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DEPARTMENT OF CONSERVATION

WATER POWER AND CONTROL COMMISSION

THE GROUND-WATER RESOURCES OF GREENE COUNTY, NEW YORK

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By

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Prepared by the

U. S. GEOLOGICAL SURVEY IN COOPERATION WITH THE

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THE GROUND-WATER RESOURCES OF GREENE COUNTY, NEW YORK

By Jean M. Berdan

ABSTRACT

This report was prepared as part of a statewide survey of the ground-water resources of New York by the U. S. Geological Survey in cooperation with the State Water Power and Control Commission. Its purpose is to provide the basic facts relating to the occurrence, quality, and availability of ground water in Greene County.

Greene County is in east-central New York. The area lies partly in the Catskill section of the Appalachian Plateaus physiographic province and partly in the Hudson Valley. The topography has been modified by glaciation. The climate is humid continental, and precipitation on the area is the source of essentially all ground water in the County.

The geologic formations in Greene County are of two principal types, consolidated rocks or bedrock, and unconsolidated deposits. The consolidated rocks range in age from Early Ordovician to Late Devonian and consist of almost every major sedimentary rock type. The older consolidated rocks are principally shale and limestone, whereas the younger ones are principally shale and sandstone. The oldest rocks are the most deformed but folds, faults, and joints are present in all the bedrock formations throughout the County. Unconsolidated deposits cover the bedrock almost everywhere in the County. Except for thin bodies of Recent alluvium, the unconsolidated materials are of Pleistocene age and are glacial or glacioaqueous deposits. The principal unconsolidated deposits are till, gravel, sand, and clay.

In the bedrock, ground water occurs in secondary openings, such as joints and openings along bedding planes, as well as in original openings such as pores in sandstone. In the limestones these openings have been enlarged by solution. Most of the bedrock formations yield small amounts of water to drilled wells. In the younger sandstones the original pore spaces also contain ground water, and somewhat larger yields are obtained from these sandstones.

The unconsolidated deposits generally have different physical characteristics from the bedrock, and water is contained almost entirely in the original pore spaces between the grains. Wells tapping unconsolidated deposits have an extreme range in yield. For example, most till (boulder clay or "hardpan") and lacustrine silt or clay are relatively impermeable, whereas saturated beds of sand and gravel ordinarily are highly permeable and may yield large quantities of water to properly developed wells.

Ground water is used extensively in Greene County, but practically all the many individual supplies are small. Thus the total amount of daily withdrawal is modest, averaging about 2 million gallons, although during the tourist season it may be as much as 3 million gallons per day.

Water from wells tapping the older shales and limestones is almost uniformly hard and commonly contains objectionable amounts of other mineral constituents, whereas water from wells penetrating the younger (Middle and Upper Devonian) sandstone is generally soft and has a lower concentration of most constituents except iron. The quality of water from wells in the glacial drift depends on the composition of the drift, which is highly variable.

INTRODUCTION

The investigation of the ground-water resources of Greene County is part of the statewide investigation by the U. S. Geological Survey in cooperation with the New York State Water Power and Control Commission. The purpose of the investigation is to assemble and evaluate readily available information on the source, occurrence, availability, and chemical quality of the ground water as an aid in the current development and utilization of the supplies, and as a basis for later more intensive investigation if needed. The index map (fig. 1) shows Greene County and the other counties and areas in which similar investigations have been or are being conducted. Reports already published are listed on the back cover of this report.

The work was done under the direct supervision of E. S. Asselstine, geologist in charge of the area office of the Geological Survey at Albany, and under the general supervision of M. L. Brashears, Jr., and J. E. Upson, successive district geologists of the Geological Survey at Mineola.

DESCRIPTION OF AREA

Greene County is in east-central New York between meridians 73°46′ and 74°33′ west longitude and parallels 42°06′ and 42°28′ north latitude. It occupies parts of the Gilboa, Durham, Coxsackie, Phoenecia, Kaaterskill, and Catskill, N. Y., 15-minute quadrangles of the Geological Survey. These maps are the base for plate 1. The County is bordered on the north by Schoharie and Albany Counties, on the west by Delaware County, on the south by Ulster County, and on the east by the Hudson River. The area of the County is 653 square miles. According to the 1950 census, the population of Catskill, the county seat and largest town, was 5,392 and that of the County was 28,745. Most of the population is concentrated in the eastern part of the County where the low-lying land and adequate transportation facilities favor agricultural and industrial development. The central and western parts of the County are in the Catskill Mountains.

METHODS OF INVESTIGATION

In 1945 and 1946, 611 wells were visited by Harry Wilson to obtain information on the depth, material penetrated, yield, drawdown, water level, general character of the water, use, and other features. Wilson visited 20 springs and obtained pertinent information on them. Much of the information was obtained from owners, tenants, and well drillers. In many cases, only incomplete records were available. Samples of water were collected from 47 wells and 1 spring in Greene County, and chemical analyses were made at the laboratory of the New York Department of Health in Albany, except for one sample which was analyzed by the U. S. Geological Survey. One chemical analysis was obtained from a private laboratory. In 1947, the author mapped the location, thickness, and extent of the water-bearing formations. Most of the field work was done by the end of that year. E. S. Asselstine added information collected since 1947, particularly on water-level fluctuations, public water supplies, and quality of water. R. C. Vorhis assisted in the preparation of part of the report. Two observation wells, G1 and G2, were established in Greene County as part of a New York State network. Periodic measurements of ground-water levels were made in both wells for about 2 years, (1947-49) and were being continued in well G1 as of the time of preparation of this report (1954). Data for about 300 of the nearly 600 wells and springs visited in the field are given in tables 3 and 6. The locations are shown on plate 1. The wells were numbered in the order they were inventoried, beginning with G1, and the springs were numbered similarly, beginning with G 1Sp.

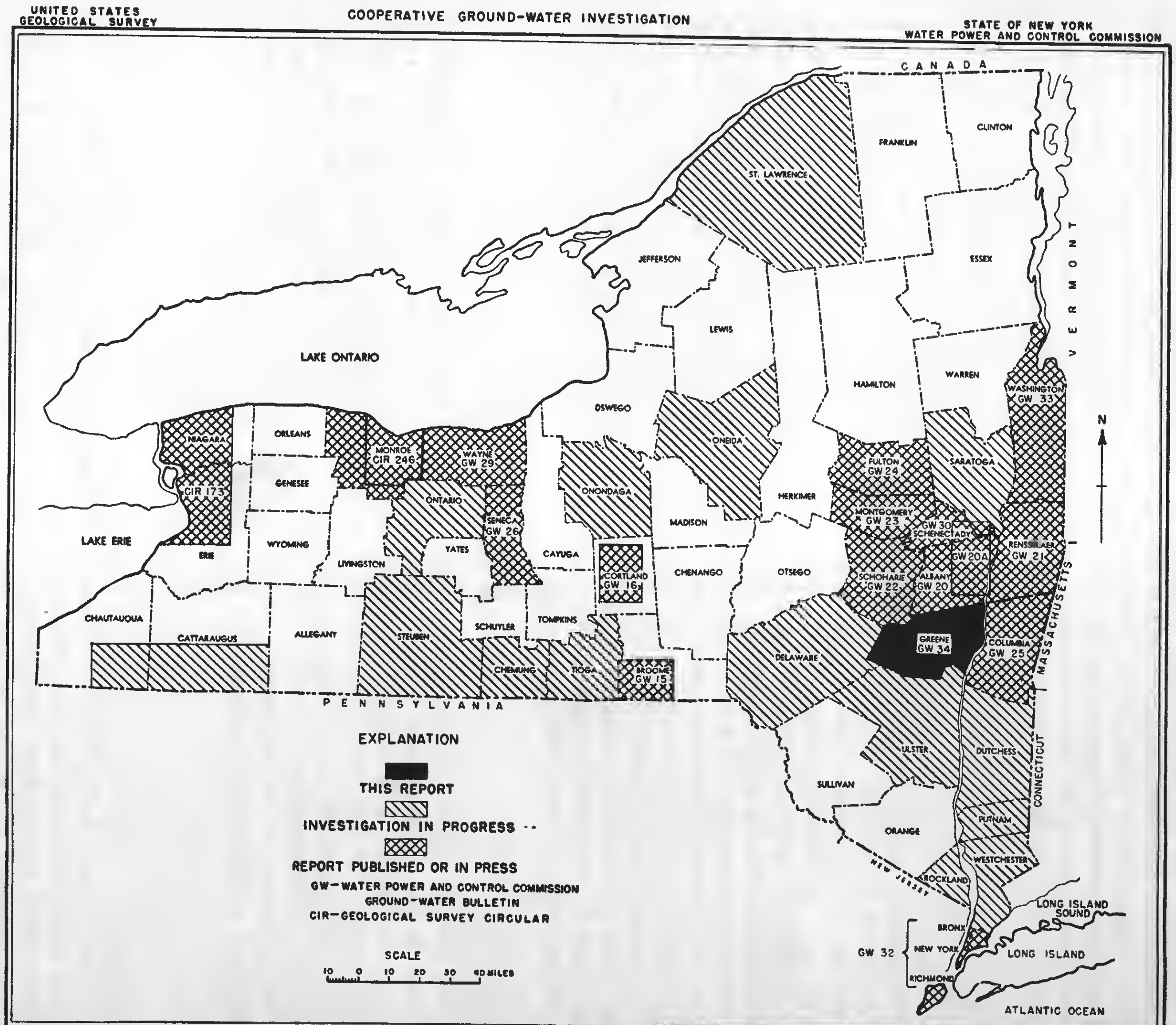

Figure 1.—Area described in this report and other areas in Upstate New York for which ground-water reports have been published or investigation is in progress.

As an aid in locating a well or spring on maps of New York State, meridian lines at 15-minute intervals are lettered consecutively from west to east, beginning with "A" for meridian 79°45′, and ending with "Z" for meridian 73°30′. Similarly, parallels of latitude are numbered at 15-minute intervals from north to south, beginning with "1" for parallel 45°00′ and ending with "17" for parallel 41°00′. The coordinate letters and numbers applying to Greene County are shown on the well-location map (pl. 1). Intersections of the coordinates form points from which the locations of wells and springs can be described by distance and direction. For example, spring G 1Sp (12V, 1.8S, 1.4E) can be found 1.8 miles south and 1.4 miles east of the intersection of coordinates "12" and "V". The coordinates, distances, and directions for each well and spring location are shown in tables 3 and 6. However, the prefix "G" has been omitted on plate 1, as all wells and springs shown are in Greene County.

PREVIOUS WORK

Greene County was included in the area of the First Geologic District of New York, which was reported on by W. W. Mather in 1838, 1839, 1840, 1841, and 1843. The hills of folded limestone in the eastern part of the County were described by W. M. Davis (1882, 1833). Stream piracy in the Catskill Mountains, including examples in Greene County, was described by N. H. Darton (1896). The most recent papers on areal geology have been written by G. H. Chadwick (1944), Winifred Goldring (1943), and Rudolf Ruedemann (1942) and together cover the eastern quarter of the County. The glacial geology of the western part of the County was described in a report by J. L. Rich (1935). The geologic map and the discussion of the geology in this report are based, in part, on material from these papers. No effort has been made to prepare a complete bibliography because extensive references are included in the various geologic reports. Thus, references listed in this report include only those papers referred to in the text. Miscellaneous information relating to ground-water conditions in Greene County is contained in many of the areal reports, but there is no previous report in which ground water is the principal subject.

ACKNOWLEDGMENTS

The generous assistance of the many public officials and private citizens who supplied information is gratefully acknowledged. State agencies have been especially helpful and include the Department of Health, which analyzed most of the water samples, the State Science Service, the Bureau of Soil Mechanics, and the Department of Commerce. The help of E. L. Snyder, superintendent of the Lehigh Cement Corp., and Richard Terman, at that time geologist of the North American Cement Corp., in interpreting rock sections in their quarries is appreciated. Winifred Goldring, former State Paleontologist, and the late G. H. Chadwick made available their considerable knowledge of the geology of Greene County.

GEOGRAPHY

TOPOGRAPHY

Greene County is in two physiographic provinces: the Hudson Valley section of the Ridge and Valley province, and the Catskill section of the Appalachian Plateaus province (Fenneman, 1938, p. 203, 283). The Hudson Valley further comprises the following physiographic subdivisions: (1) a level terrace bordering the river, (2) a range of low hills about a mile wide known as the Kalberg, and (3) an area of higher hills known as the Hoogeberg. Figure 2 shows these physiographic areas diagrammatically and also their general relation to the underlying rocks in Greene County. The topographic map, plate 1, also shows the physiographic areas.

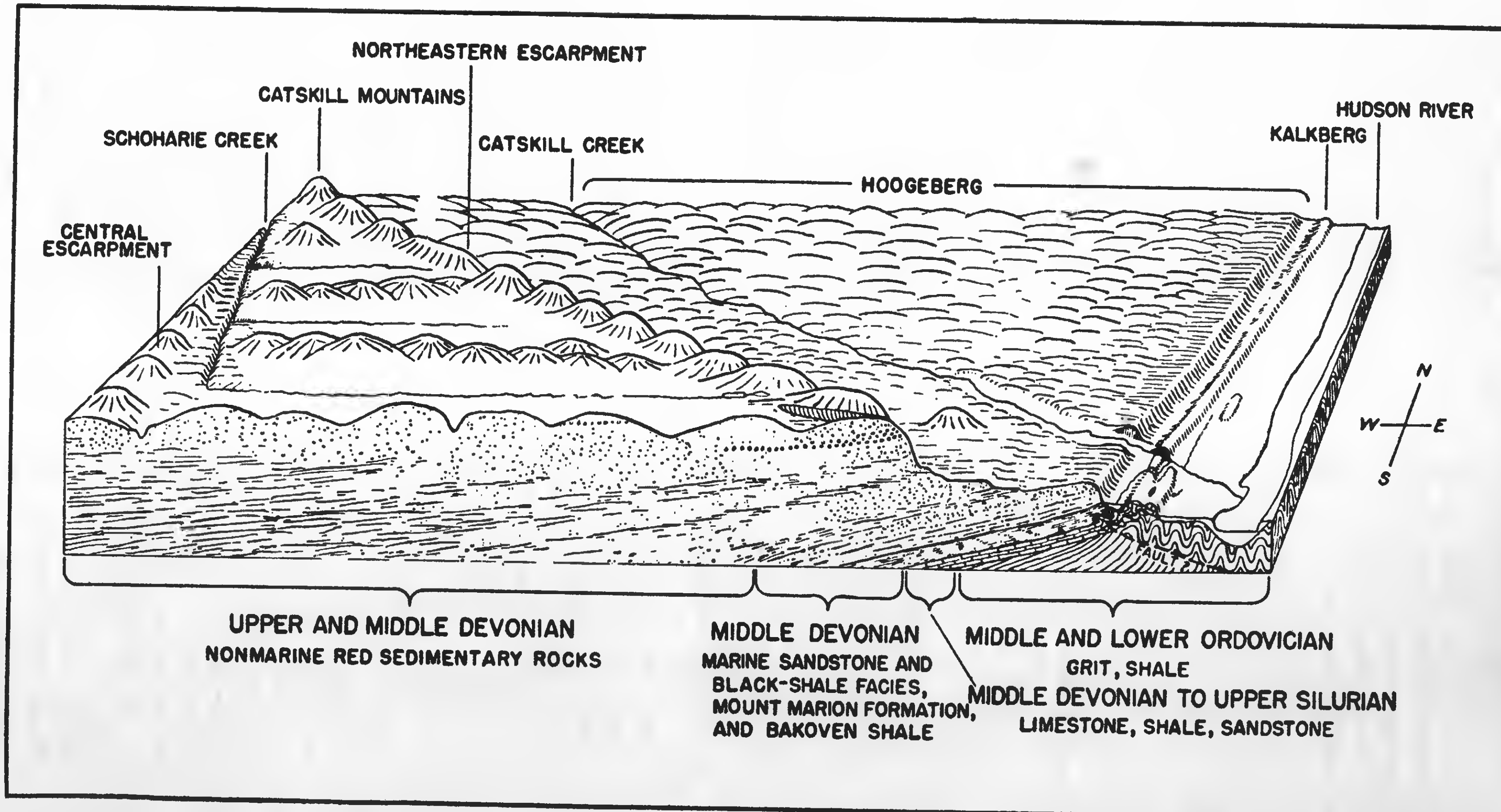

Figure 2.—Diagrammatic sketch showing relation of topography to the underlying rocks in Greene County.

The terrace bordering the Hudson River has an average altitude of about 100 feet above sea level in the south and about 150 feet in the north. The present Hudson River is entrenched about 100 feet in these deposits. South of Catskill this terrace is narrow, but between Athens and Coxsackie it is about 4 miles wide. The terrace is underlain by terrace deposits, flat-lying beds of sand and clay whose original surface has been dissected by short tributaries of the Hudson River producing gullies. Shale and sandstone of Ordovician age underlie the sand and clay, and protrude locally to form low hills.

The Kalkberg (from the Dutch for "limestone mountain") is a range of low hills parallel to and at the west margin of the terrace along the Hudson. The contact with the terrace surface is sharp nearly everywhere. The range of hills is mainly less than a mile wide, and individual hill summits range in altitude from 300 feet in the south to 500 feet in the north. The hills are formed of limestone, shale, and sandstone of Late Silurian and of Devonian age, which are the same rocks that compose the Helderberg escarpment in Albany County to the north. The hills form a double ridge in many places owing to the presence of two beds of resistant limestone separated by a thick stratum of less resistant siltstone. Where the limestone is at the surface, caves and sinkholes are common, and streams pass underground at many places. The Hoogeberg (Dutch for "high mountain") in southern Greene County is a range lying between the Kalkberg on the east and a broad plain, Kiskatom Flats, on the west. The Hoogeberg portion of the Hudson Valley, in northern Greene County, is a triangular area lying between the Kalkberg on the east and the valley of Catskill Creek on the southwest. It is composed of numerous rounded hills, not in distinct ranges. The summits near the Hudson are at about 600 feet in the southern part of the County and 800 feet in the northern part. In the southern part of the County the rocks have a gentle westward dip, so that here the hills form steep eastward-facing scarps and gentler western slopes. They rise toward the Catskill Mountains like a flight of giant steps. In the north-central part of the County, the dip of the underlying rocks changes to southwest, and the front of the Catskill Mountains trends northwest. The steplike character of the hills remains but is largely obscured by glacial deposits. In the northern part of the County, the summits increase in altitude from 800 feet near the Hudson River to about 1,000 feet at Durham and continue to increase toward the northwest to merge with the 2,000-foot plateau in Albany and Schoharie Counties. Fenneman (1938, p. 206) has referred to this increase in height as a "ramp" between the Hudson Valley province and the Appalachian Plateaus province and notes that for a distance of about 15 miles in northern Greene County the boundary between the two is indefinite and arbitrary.

The Catskill Mountains, although structurally a part of the Appalachian Plateaus province, rise nearly 2,000 feet above the adjacent parts of the plateau on the north and west. The mountains occupy the southwestern half of Greene County and rise to altitudes of more than 4,000 feet. In southern Greene County the eastern slope of the mountains is a prominent escarpment, commonly referred to as the mural front which stands nearly 3,000 feet above the summit levels of the Hoogeberg at its base. Farther north, the altitude of the Hoogeberg summits increases, and the east-facing escarpment or so-called mural front rises less than 2,000 feet above them. Although the peaks of the Catskills generally are highest near the mural front and decrease in height toward the west and northwest, the highest place in Greene County lies some distance west of the front, south of the valley of Schoharie Creek. It is Hunter Mountain, which has an altitude of 4,025 feet. The mountains, and especially individual ranges, are primraily the products of stream erosion.

In addition to these major topographic features which result from erosion as influenced by the type and attitude of the bedrock, numerous minor erosional and depositional features were formed by the last great ice sheet, which is believed to have covered Greene County com-

pletely. Features of glacial erosion are common in the mountains and include rounded hill profiles and U-shaped stream valleys. Sharp gulfs, such as Deep Notch and Stony Clove, were formed primarily by stream erosion. The depositional features left by the ice are more prominent than the erosional and locally modify the main topographic features. The flat plain along Catskill Creek, called Sandy Plain, like the terrace along the Hudson River, was formed of sand and clay deposited by streams from melting ice. Also, many deposits of gravel form low hills locally. Other hills of till, called drumlins, are numerous in the north-central part of the County near Durham and Greenville.

DRAINAGE

All of the County except the western corner is drained directly or indirectly by tributaries of the Hudson River. The longest stream is Catskill Creek, which flows southeastward parallel to and northeast of the Catskill Mountain front and drains a substantial part of the Hoogeberg. Kaaterskill Creek drains the southeastern part of the County. It heads west of the mountain front near Haines Falls, and after passing down the deep gorge in the mountain front at Kaaterskill Clove it joins Catskill Creek near Leeds. Numerous short streams flow into the Hudson River from the valley flat and the Kalkberg. The longest of these are Coxsackie and Hannecrois Creeks. In the mountains, the principal drainage system is that of Schoharie Creek and its tributaries, Batavia Kill, East Kill, and West Kill, which flow north to the Mohawk. The Mohawk, in turn, joins the Hudson near Albany. In the southern and southeastern parts of the mountains, several streams flow southward out of the County to join Esopus Creek, another tributary of the Hudson River. The most important of these is Plattekill Creek.

In the extreme southwest corner of the County, in the Township of Halcott, Vly Creek and its tributaries flow to the East Branch of the Delaware River.

Kaaterskill and Plattekill Creeks, in the south-central part of the County (pls. 1, 2), have eroded deep gorges (Kaaterskill and Plattekill Cloves) in the mountain front, and because of their relatively steep gradients and short courses they have diverted or "captured" some of the headwater streams of Gooseberry Creek and Schoharie Creek. This relationship was noted by Darton (1896, p. 505-507). Cressey (1953, p. 73) observed that, since Darton's original observations and the publication of the topographic map of the Katterskill quadrangle in 1903, Kaaterskill Creek had captured also the easternmost tributary of Gooseberry Creek half a mile southwest of Haines Falls. Cressey mentions that in 1934 the piracy was not quite complete, but that Kaaterskill Creek was already receiving ground-water flow from the creek subsequently captured.

The most recent drainage change in the County is an artificial one resulting from the construction of the Schoharie dam at Gilboa in Schoharie County. The waters of Schoharie Creek are now diverted eastward under the mountains through the Shandaken tunnel as part of the New York City water supply.

Stream-gaging stations are maintained by the Geological Survey on both Catskill Creek and Schoharie Creek. Records of streamflow for Catskill Creek at Oak Hill (drainage area of 98 square miles) have been obtained since 1929, and records for Schoharie Creek at Prattsville (drainage area of 236 square miles) have been obtained from 1902 to 1913 and from 1931 to the present. These data are published annually in Geological Survey water-supply papers entitled "Surface water supply of the United States, Part 1, North Atlantic Slope basins". Current measurements, prior to publication, are on file at the office of the U. S. Geological Survey, Albany, N. Y.

CLIMATE

Greene County has a temperate climate of the humid continental type, marked by seasonal extremes of heat and cold. There is probably a considerable variation in both precipitation and temperature between the valley lands along the Hudson River and the mountains. Meteorological observations have been made since 1924 at Cairo, N. Y., a substation of the U. S. Weather Bureau, in the east-central part of the County. Available records for the period 1935 to 1953 are summarized in table 1.

Table 1.—Precipitation and temperature at Cairo, N. Y. for the period 1935 to 1953

Year	Precipitation, in inches			Last frost	First frost	Temperature, in °F		
	Annual	Monthly				Annual		
	Total	Max.	Min.			Mean	Max.	Min.
1935	31.41	8.02	0.37	May 5	Oct. 3	49.3	96	—16
1936	37.81	7.09	.96	May 21	Sept. 26	50.1	102	—18
1937	49.50	5.96	1.76	Apr. 26	Oct. 9	50.8	98	6
1938	41.85	9.19	.78	May 14	Oct. 8	51.1	98	—26
1939	27.54	3.86	.82	May 14	Oct. 16	50.2	98	— 2
1940	35.32	5.40	.54	Apr. 29	Sept. 27	47.7	98	—10
1941	27.80	5.09	.78	May 14	Sept. 30	50.9	98	— 3
1942	—	—	—	May 11	Sept. 30	—	—	—
1943	35.95	7.39	.61	May 15	Oct. 6	49.2	100	—26
1944	35.98	4.94	1.41	May 19	Oct. 16	50.0	101	—14
1945	—	—	—	—	—	—	—	—
1946	32.14	5.60	.48	May 9	Oct. 3	48.4	95	— 5
1947	39.07	6.46	.78	—	Sept. 26	46.4	95	—12
1948	38.38	6.18	.88	May 2	Oct. 16	48.6	106	—25
1949	27.58	4.21	.65	Apr. 29	Oct. 25	—	102	—
1950	38.50	6.39	1.67	May 9	Sept. 25	49.4	94	—15
1951	47.83	6.56	1.38	Apr. 21	Sept. 30	50.8	95	—17
1952	49.34	6.09	.95	Apr. 12	Oct. 8	50.7	101	2
1953	43.60	6.35	1.87	Apr. 22	Sept. 24	51.7	100	5

The mean annual precipitation at Cairo for the period of record is 37.71 inches. In general, precipitation is rather evenly distributed throughout the year, a little less occurring in winter than in the other seasons. Monthly maximums and minimums for various years do not fall in any specific groups of months but may occur in any of the 12 months. Unusually dry years were 1939, 1941 and 1949. Very wet years were 1937, 1951, and 1952 when the precipitation exceeded the normal by more than 10 inches.

The mean annual temperature for the period of record is 49.5°F. As may be seen from the table, the yearly average temperature deviates little from this long-term norm. The greatest temperature range in this time was in 1948, with a range from 106°F to —25°F. The highest temperatures generally occur in July or August and the lowest in January or Feb-

ruary. The average length of the growing season computed from data in table 1 is 152 days. The longest recorded season was 179 days in 1949 and 1952, and the shortest 128 days in 1936. The last killing frost usually occurs in the last week of April or in the first two weeks of May. The first killing frost usually occurs in the last two weeks of September or the first week of October.

GEOLOGY

The rocks of Greene County comprise two major types: (1) consolidated bedrock of sedimentary origin, and (2) unconsolidated surficial deposits of alluvial or glacial origin. The consolidated rocks underlie the entire area, are much the older, and have been distorted and broken by folds, faults, and joints. The unconsolidated deposits occur nearly everywhere in the County as a mantle over the consolidated rocks. They are thickest and most extensive in the valleys and other lowland areas. In the following pages, the sequence of geologic formations in Greene County is discussed, and the results of deformation are described. The distribution of the principal bedrock units is shown on plate 2 and the distribution of the two major types of unconsolidated deposits is shown on plate 3. The physical characteristics and water-bearing properties of the various formations are described under the heading Occurrence and availability of ground water (p. 13) and summarized in table 2.

GEOLOGIC HISTORY AND SEQUENCE OF FORMATIONS

The recorded geologic history of Greene County begins with the deposition of muds and sands in a shallow sea in the Early and Middle Ordovician epochs. In the Late Ordovician, the sea withdrew toward the west, and the marine sediments, which became the Deepkill and Normanskill shales, were folded and uplifted into mountain ranges and began to be eroded. As the Ordovician period ended, these rocks are believed to have been broken along a fault, and a portion of them thrust westward (fig. 2). In Greene County the fault is concealed beneath younger deposits, but it has been reported in areas to the north and south.

Erosion continued in Early and Middle Silurian time and the mountains were reduced to a low, flat plain. By Late Silurian time the sea once more advanced over the area. In this sea a thick sequence of muds and limy muds accumulated above the Normanskill shale. This deposition continued in Late Silurian and the Early and Middle Devonian time. The deposits formed rocks now known from oldest to youngest as the Rondout and Manlius limestones, Coeymans, Kalkberg, New Scotland, Becraft, Alsen, and Port Ewen limestones (Coeymans to Port Ewen referred to in this report as the Helderberg group), Glenerie limestone (of Chadwick, 1908), Esopus shale, Schoharie grit, Onondaga limestone, and Bakoven shale. As the sediments composing these formations were largely limy muds or sands consisting of fragments of shells, the sea was evidently shallow and bordered by low-lying lands. Late in the interval the land to the northeast began to rise, resulting in cessation of lime accumulation and deposition of the black mud that became the Bakoven shale.

With continued uplift of the landmass to the northeast in the Middle Devonian, the deposits changed from black mud to gray silt and sand laid down near shore. These silty and sandy sediments later were consolidated into the rocks of the Mount Marion formation which overlies the Bakoven shale. By Middle Devonian time, a delta extending westward from the rising landmass had advanced so far across the County that the sea was completely excluded, and the sand and silt were deposited in fresh water or under subaerial conditions to form the Ashokan formation, which overlies the Mount Marion formation. While the Ashokan formation was being laid down in the southern part of the County, deposition of the marine Mount Marion formation was still going on in the northern part. Hence, there the marine beds are thicker and the uppermost strata may be equivalent in age to the lowermost ones of the Ashokan.

Subaerial deposition of sands, silts, and muds continued throughout the Middle and Late Devonian. Streams formed a great alluvial fan, or series of coalescing fans, that extended far to the west beyond Greene County. The deposits thus formed became the Catskill formation, which is transitional with the underlying Ashokan formation. The Catskill formation underlies about five-sixths of the County, including the foothill slopes and the main mass of the Catskill Mountains. The rocks of the Catskill formation are the youngest consolidated rocks in Greene County.

Deposition of the Catskill formation was brought to a close by general uplift, so that Greene County became an area of erosion rather than one of deposition. Erosion continued, possibly interrupted by brief intervals of deposition of continental deposits which since have been removed, throughout the remainder of the Paleozoic, Mesozoic, and most of the Cenozoic eras, until the beginning of the Pleistocene epoch, by which time the topography of Greene County had acquired its present main features and general aspect. During the Pleistocene epoch, continental ice sheets or glaciers advanced across the County from the north and then melted. It is believed that in the latest of the generally recognized stages of ice advance the glacier became thick enough to submerge completely the highest peaks in the Catskill area. As the ice advanced, it smoothed and rounded hills and deepened valleys. It deposited a layer of unsorted debris (till), which rests upon one or other of the consolidated-rock formations. As the ice melted away, glacial lakes formed in some valley areas, among them the valleys of the Hudson River, Schoharie Creek, and Batavia Kill. Deposits, principally of clay and silt, were laid down in these glacial lakes. Deposits of stratified sand and gravel were formed in the valleys by melt-water streams flowing from the ice as it melted away. At the close of the Pleistocene epoch, the topography of Greene County appeared much as it does today.

During Recent time, small bodies of clay, silt, and sand have been deposited on the flood plains of the larger streams in the County.

GEOLOGIC STRUCTURES

The rocks of Greene County were deformed in at least two main episodes, one near the close of the Ordovician period, the other during and after the Devonian period. The rocks probably were disturbed also during later episodes of deformation that affected younger formations in adjoining States, but of which there is little direct evidence in Greene County. All these disturbances resulted in the development of folds and fractures, which occur in varying degrees in the several bedrock formations. Folds are bends or plications of the layers or strata that compose the formations. Fractures are of two types: those along which differential movement has taken place, called faults, and those along which no movement or only slight movement has taken place, called joints. Faults are major features, generally associated in Greene County with folds, and not in themselves of much significance with respect to ground water. Joints are much more numerous and of greater significance because they provide openings in which ground water may be stored and through which it can move. The type and degree of development of the structures in the various formations, and their effect on water-bearing characteristics, differ somewhat. The geologic structures of the several formations or groups of formations are discussed in following paragraphs under the headings of (1) folds and faults, and (2) joints.

Folds and Faults

The oldest rocks, the Deepkill and Normanskill shales, are the most deformed, having been compressed and folded on a large scale at least twice in geologic time. These formations

are believed by some geologists to be part of a block thrust to the west. The trace of the hypothetical thrust plane, as shown in figure 2, lies beneath the formations of the Helderberg group (Chadwick, 1944, p. 179). Of the strata of the Deepkill and Normanskill the beds of shale are closely plicated, but the more rigid beds of chert and grit lie in relatively open folds that strike about N. 20° E. (Goldring, 1943, p. 200).

The overlying formations, from the Rondout limestone to the Onondaga limestone inclusive, were deformed on a major scale only once, but nevertheless they were so disturbed that their structure is complex. Details of the structure have been presented by Chadwick and Goldring, who showed that folding and faulting in the limestone decrease in intensity from south to north. From the County line north to Catskill, the beds are folded into a long anticline trending between N. 10° E. and N. 20° E., with reentrant synclines at the Great Vly and Fuyk Valleys. This anticlinal fold is broken by four to five thrust faults which piled the limestone in slices, themselves later folded. Between Catskill and Climax, the latter a small village in Coxsackie Township, the folds are smaller but more numerous. Also, several long normal faults parallel the strike of the beds (Goldring, 1943, p. 303-305). From Climax north to the County line there are few faults, and the folds are broad and open. At most places the eastern edge of the area underlain by these rocks is marked by an east-facing scarp formed of steeply dipping strata of the Manlius and Coeymans limestones. These beds strike generally east of north and in most of the County dip toward the northwest. However, in the northern part, north of Climax in the vicinity of High Rocks, the dip is toward the southwest (Goldring, 1943, p. 295).

West of the area underlain by the Rondout to Onondaga limestones most of the younger formations are much less deformed. The deformational stresses were largely taken up by rather intense deformation of the incompetent Bakoven shale (fig. 2), whose lower part wherever exposed is seen to be distorted and marked by slickensides. However, the overlying Mount Marion formation dips at an angle of only about 7° northwesterly at the southern end of Potic Mountain (north of Leeds) and east of Medway. The dip of the strata in the still younger Ashokan and Catskill formations is a few degrees in the eastern part of the County, but in the western part it is so low that the strata are essentially flat lying. The Catskill formation forms a broad, scoop-shaped syncline; the strata in the southern part of the County dip gently to the west or northwest and in the northern part to the southwest. These strata are not noticeably faulted, but Chadwick (1944, p. 17) has recorded several cases of "keystone faulting"—the down-dropping of a wedge of rock in a zone of closely spaced joints.

Joints

Joints are characteristically open fractures, at least within a few hundred feet of the land surface, and therefore are capable of storing and transmitting ground water. Hence, their distribution, spacing, and direction are of importance in Greene County, where most bedrock retains little original pore space, and where generally ground water is most readily obtainable from joints.

The strikes of joints have been observed at 45 localities in Greene County and are shown diagrammatically in figure 3. Each short line on the diagram represents the strike of a joint or several joints as measured at one locality. No strikes were measured for joints in the Normanskill shale. Strikes were measured for joints in the limestones (Rondout to Onondaga) and in the sandstones and shales of the Catskill formation.

The joints do not fall into narrowly defined sets, but they do seem to form two general groups, one in the northeast quadrant roughly between N. 58° E. and N. 74° E., the heaviest concentration being around N. 63° E., and the other in the northwest quadrant, ranging from

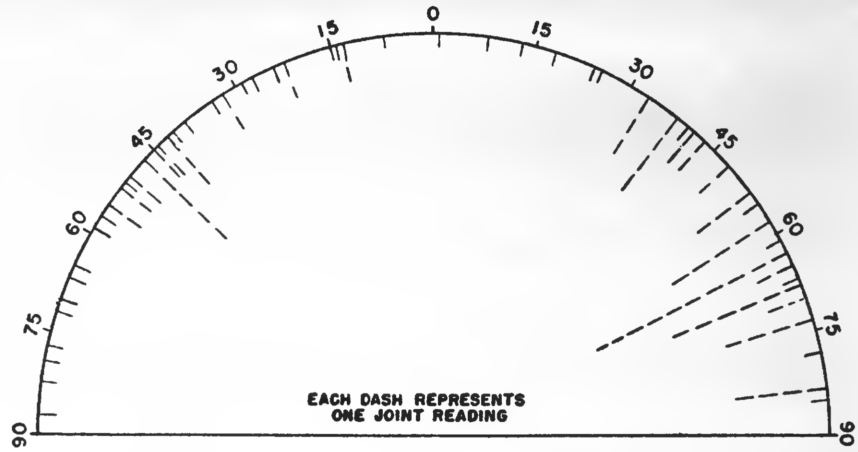

Figure 3.—Diagram showing strikes of joints in bedrock.

roughly N. 42° W. to N. 55° W., and centering around N. 47° W. These two groups of joints seem to correspond with sets II and III recognized by Parker (1942, p. 292-3). At several localities, two joints apparently belonging to the same set have strikes that are approximately 10° apart; also, some individual joints do not maintain a constant strike, but vary by a few degrees. The joint strikes are most consistent in the southern and eastern parts of the County, but no progressive change in direction farther north and west appears to exist. At some localities only one set of joints is well developed.

Most of the joints are vertical, but at some localities they dip at steep angles. In shale and siltstone, many of the joint surfaces are curved, and the direction of dip is variable. Where solution has occurred, as in limestone, the original joint surface may be completely dissolved, and the true angle of dip may be obscured by irregular widening.

The joints in limestone are generally spaced 2 to 4 feet apart, in sandstone 1 to 3 feet, and in shale and siltstone 1 to 3 feet. However, the spacing varies from place to place.

The joints appear to exercise some control over both minor and major features of the topography and drainage. At most places where streams flow directly on bedrock, joints impose a zigzag minor pattern. The streams flow parallel to one set of prominent joints and cross another set in a series of falls, ordinarily changing direction within short distances from one joint set to another. Examples are Red Falls on Batavia Kill, Great Falls on Kaaterskill Creek, Quatawichna-ach on Kaaterskill Creek, and Austins Glen on Catskill Creek. Possibly the straightness of the so-called "mural front" of the Catskill mountains is in part due to the control of joints that strike N. 20° E. to N. 33° E.; and the minor reentrants, in the front, such as that at the Mountain House above Palenville, are due to joints that strike N. 73° E.

Joints also control to some extent the circulation of ground water. This is most obvious in the area underlain by limestone where both sinks and springs occur along joint planes. At Quatawichna-ach, Kaaterskill Creek disappears into the Onondaga limestone along joints and

emerges about 300 yards away along bedding planes. Similarly, spring G 16Sp, which emerges along a bedding plane on the top of an impermeable stratum at the nose of a plunging syncline on the north end of Quarry Hill near Catskill, is apparently maintained by drainage into a sink in the hill above. The sink is at the intersection of joints in the Kalkberg limestone and was doubtless developed by solution along the joints.

A series of closely spaced fractures in the rock, all more or less parallel, and along which there may have been slight movement, is known as fracture cleavage. Such cleavage commonly cuts across the bedding and is related to other regional structures. It is considered to be the result of shearing stresses. An otherwise impermeable stratum or formation may contain considerable water in zones of fracture cleavage. In Greene County, fracture cleavage commonly develops in the shale and siltstone of the Esopus and Schoharie formations, in the shale beds of the Deepkill and Normanskill, at some localities in the shaly New Scotland limestone, and occasionally even in massive limestone, such as the Manlius.

GROUND WATER

OCCURRENCE AND AVAILABILITY

Ground water, like surface water, is part of the natural drainage system and moves by gravity toward lower levels, but instead of flowing freely it must move through fractures, solution channels, or interstices between grains. Thus, the amount of ground water that is present below the surface in any region and the manner and rate of its movement to wells or springs are controlled largely by the lithology of the geologic formations and the number and kinds of openings in them. The formations in Greene County are of two principal types, consolidated rocks and unconsolidated deposits, and are mapped as 9 principal water-bearing units. They are discussed in the following pages under these two divisions. Table 2 summarizes the age, lithology, and water-bearing properties of the formations.

Consolidated Rocks

The bedrock, which underlies all of Greene County (pl. 2), contains examples of the three major sedimentary rock types—sandstone, shale, and limestone. The different rock types have been affected differently by deformation and locally have undergone solution by moving ground water. All these factors have a bearing on the occurrence, availability, and quality of the ground water. With respect to these factors, the consolidated rocks can be placed in three main groups. The first group comprises the Deepkill and Normanskill formations which underlie a north-south belt in the Hudson Valley extending from the river westward to and 1 to 2 miles beyond U. S. Route 9W. (See pl. 2) These formations, which include both shales and sandstones, reacted to the deformational stresses by locally complex folding and jointing. However, water-bearing openings are relatively few and narrow. The second group comprises 3 principal water-bearing units ranging in age from Late Silurian to Middle Devonian: namely, the Rondout and Manlius limestones, and Helderberg group; the Glenerie limestone (of Chadwick, 1908), and Esopus shale; the Schoharie grit, Onondaga limestone, and Bakoven shale. These formations underlie a narrow north-south belt 1 to 2 miles wide, parallel to the Hudson Valley. They consist of alternating limestones and shales, which have been moderately deformed. The limestones are characterized by joints and openings along bedding planes which commonly have been enlarged by solution. These carry considerable ground water but are widely spaced. In the shales, ground water occurs chiefly in joints and in zones of fracture cleavage. The third group comprises the Mount Marion, Ashokan, and Catskill formations. The rocks of this group underlie the remainder of the County, nearly 90 percent of the area. They are sandstones interbedded with shales; most of the beds are of

Table 2.—Geologic formations in Greene County, and their water-bearing properties

Age: System	Age: Series	Geologic formation or group	Thickness (feet)	Character of material	Water-bearing properties
Quaternary	Recent	Alluvium	20±	Sand, silt, and gravel in stream beds.	Yields little water because of small size of most deposits. In larger valleys, large supplies locally obtained by induced infiltration from streams.
	Pleistocene	Stratified sand and gravel	Up to 150	Fine to coarse-grained sand and gravel in interbedded lenses; many are crossbedded.	Yields appreciable quantities of ground water. Wells have average yield of 22 gallons per minute (gpm); moderate to large supplies obtainable from properly constructed wells. Water generally soft.
		Lacustrine deposits	Up to 300	Fine clay and silt, some sand; in thin, fairly uniform, and extensive strata.	Yields little water except where very sandy.
		Till	1 to 100+	Heterogeneous mixture of gravel, sand, clay, and boulders, with a predominance of clay.	Yields small supplies to dug wells, chiefly for domestic and farm purposes. Water ranges from soft to hard.
Devonian	Upper and Middle Devonian	Catskill formation	5,500	Gray sandstone, dark-gray fine-grained sandstone, red sandstone, red, green, and gray shale.	Most productive bedrock formation. Wells have average yield of 20 gpm from sandstone, 15 gpm from so-called bluestone, 14 gpm from shale. Wells average 135 feet in depth. Water generally soft or only moderately hard.
	Middle Devonian	Ashokan formation	250 to 350	Gray arkosic laminated sandstone alternating with olive-green, rusty-weathering shale.	Yields small supplies to wells chiefly from fractures and openings along bedding planes. Wells average 135 feet in depth; 7 gpm in yield. The single analysis recorded shows hard water low in iron.
		Mount Marion formation	700 to 1,100	Gray, brown-weathering sandstone and dark-gray shale with marine fossils.	Yields small supplies to drilled wells, which average 210 feet in depth. Yield consistently low, averaging 3 gpm; several dry holes reported. Water soft, but the one recorded analysis indicates high iron concentration.
		Bakoven shale	140 to 200	Black to dark-gray fissile shale with brown streaks; contains pyrite.	No wells reported to obtain water from this formation.
	Middle or Lower Devonian	Onondaga limestone	80±	Massive light- to blue-gray crystalline limestone with seams of chert. Locally has fossil corals.	Yields small to moderate supplies to drilled wells that encounter joints and bedding planes enlarged by solution. Average yield 8 gpm. Springs common. Water may be contaminated locally because of lack of natural filtration in subterranean streams.
		Schoharie grit	80±	Shaly limestone; contains seams of chert.	Acts as hydrologic unit with Onondaga; see above.
		Esopus siltstone	250	Drab to brown massive siltstone; fracture cleavage well developed; few fossils.	Yields small to moderate supplies to drilled wells. These have average depth of 120 feet. Water occurs in openings along cleavage planes; average yield of 10 gpm and static levels are relatively deep at most places.
	Lower Devonian	Glenerie limestone (of Chadwick, 1908)	6 to 20	Impure siliceous limestone; contains seams of chert; dark gray when fresh and weathers buff or red. Fossiliferous.	Same as Esopus siltstone with which it is believed to act as a hydrologic unit.
		Helderberg group	300±	Shaly limestone, cherty limestone, and massive crystalline limestone. Highly fossiliferous.	Yields small to moderate supplies to drilled wells. These average 125 feet in depth and range in yield from 1 to 30 gpm. Average yield is 7 gpm. Water commonly hard but hardness chiefly of carbonate type.
Silurian	Upper Silurian	Rondout and Manlius limestones	50 to 80	Massive dark-gray, light-weathering limestone; some shaly and sandy limestone. Fossiliferous.	
Ordovician	Middle Ordovician	Normanskill shale	1,000±	Gray sandstone, with chert and dark-gray shale.	Yields small supplies of water to drilled wells, which average 148 feet in depth. Average yield about 6 gpm. Water commonly hard, chiefly carbonate hardness. Iron concentration locally excessive.
	Lower Ordovician	Deepkill shale	200±	Green siliceous shale, black shale, and thin-bedded limestone and chert.	Yields small to moderate supplies to drilled wells. Yield and depth of wells range widely; average yield about 10 gpm. Water exceedingly hard. Noncarbonate hardness relatively high; iron concentration locally exceeds limit of 0.3 ppm recommended by U. S. Public Health Service.

continental origin. These formations have been distorted very little but are traversed by joints. Ground water occurs partly in joints and openings along bedding planes and partly in pores. The coarser grained parts of the Catskill formation have the largest yields of all the bedrock.

In following paragraphs, the detailed information is given on lithology, water-bearing properties, and yields of the 7 water-bearing units that are consolidated rocks.

Deepkill and Normanskill shales.—The Deepkill and Normanskill shales underlie an area 1 to 3 miles wide in the extreme eastern part of Greene County. The two formations are mapped together on plate 2; most of the outcrop shown is that of the Normanskill shale, which actually underlies sand and clay of Pleistocene age but forms some low, rounded hills. The Deepkill shale is largely covered by the Normanskill and crops out chiefly in a narrow band about 4 miles long adjacent to the Hudson River near Coxsackie. About 70 wells for which there are records are situated on the outcrop of the Normanskill, and about 20 of these are reported to pass through the overlying Normanskill shale and penetrate the underlying Deepkill shale. Of these wells, records for 14 are given in table 6.

The Deepkill shale consists mainly of green siliceous shale, sandy shale, black graptolite-bearing shale, and some thin beds of limestone and chert. The thickness at Stuyvesant, in Columbia County across the Hudson River, is at least 200 feet (Goldring, 1943, p. 98), but the thickness in Greene County is not known. The water-bearing properties of the Deepkill are probably similar to those of the shale beds of the Normanskill, but few data are available. About 20 wells pass through the Normanskill and encounter limestone that is considered to be the Deepkill. Most of these wells are in Athens and Coxsackie Townships and in the southern part of Catskill Township near Alsen and Cementon. These wells range in depth from 65 to 600 feet. The range in yield of 17 wells is from 0.5 gallon per minute to 32 gallons per minute (gpm) and the average yield is 10 gpm.

Chemical analyses have been made of water samples from four wells believed to produce water from the limestone of the Deepkill shale (table 4). The hardness of this water expressed as calcium carbonate ranges from 290 to 510 parts per million (ppm). The noncarbonate ("permanent") hardness is higher than for most of the other aquifers, ranging from 51 to 305 ppm. The iron concentration in water from two of the four wells sampled exceeds 0.3 ppm.

The Normanskill in this area is composed chiefly of gray arkosic sandstone with some chert and dark-gray to black shale. The chert is black, red, or green nodules that weather white. The rocks of this formation are dense and practically impervious. Many of the beds of sandstone are so well cemented that when fractured they break across the quartz grains. The Normanskill is about 1,000 feet thick.

The entire formation is greatly folded and faulted. The beds of shale are distorted into intricate closed folds, whereas the more competent beds of sandstone and chert form open folds. These competent beds, however, being brittle, are also broken by numerous fractures, or joints. The ground water produced from the Normanskill is in these joints.

The yields of 53 wells in this formation average 6 gpm and range from less than ½ to 28 gpm. Because of the erratic distribution of the beds containing joints it is difficult to predict the success or failure of a well. For example, of two wells drilled on the same property, one may yield an ample supply, the other none or an inadequate supply. However, rarely is a well drilled without obtaining some water. Available records of wells in the County show one dry hole in the Normanskill shale. The depth of wells in the Normanskill averages 148 feet and ranges from 40 to 360 feet. The fractures in the Normanskill diminish in size and pinch out

within a depth of about 200 feet. Few wells obtain appreciable additional water below that depth.

The average static water level in 23 wells ending in the Normanskill is about 20 feet with a range from 1 to 125 feet.

Water from the Normanskill shale is high in mineral content, as shown by four available analyses (table 4). The dissolved solids in two of the analyses exceeds 1,000 ppm, and the range is from 459 to 1,120 ppm. The hardness ranges from 100 to 330 ppm and the bicarbonate content from 278 to 522 ppm. The absence of noncarbonate hardness is noted in three of the four analyses and also in five analyses of water from the Normanskill in adjacent Columbia and Rensselaer Counties. Iron concentration exceeds 0.3 ppm at several places, both in Greene County and in adjacent counties.

Rondout and Manlius limestones and Helderberg group.—The sequence of limestones from the Rondout limestone through the Helderberg group (of which the uppermost formation is the Port Ewen limestone) underlies a narrow belt, less than 1 mile wide, which extends from the northern to the southern boundaries of the County. These limestones are shown on plate 2 as one unit adjoining the Deepkill and Normanskill unit on the west and may be approximately located on plate 1 by a line passing through the towns of Cementon and Climax. The limestones have been considerably folded and faulted locally, the intensity of the deformation increasing from north to south. The more massive beds form cliffs, so that topographically the belt is marked by an almost continuous escarpment about 100 feet high rising above the Hudson Valley, backed by short, steep parallel ridges.

The Rondout limestone of Late Silurian age ranges from 10 feet of drab waterlime in the northern part of the County to 30 feet of sandy and reefy beds in the southern part. At many places it is concealed beneath talus from the overlying Manlius limestone, also of Late Silurian age. The Manlius limestone is a dark fine-grained laminated limestone which weathers light gray. The Manlius forms cliffs together with overlying Coeymans limestone. The thickness of the Manlius limestone in Greene County ranges from 40 to 50 feet. The Manlius is consistently hard and, therefore, forms cliffs even though it is thin bedded.

The Helderberg group of Devonian age consists of approximately 300 feet of highly fossiliferous crinoidal, cherty, and shaly limestone which is divided into six formations, the Coeymans, Kalkberg, New Scotland, Becraft, Alsen and Port Ewen limestones, in ascending order. The Port Ewen is here included in the Helderberg group in conformity with the Devonian correlation chart (Cooper and others, 1942) and on the basis of faunal evidence. Lithologically the Coeymans and Becraft are fairly pure limestones composed in large part of crinoid debris and fragments of other fossils, the Kalkberg and Alsen are cherty limestones, and the New Scotland and Port Ewen are very impure shaly limestones. The Coeymans, together with the underlying Manlius, and the Becraft have been extensively quarried for lime throughout the County, and large quarries are active at the present time in the area south of Catskill.

The Rondout and Manlius limestones, and the Helderberg group are here considered to act together as a hydrologic unit in the storage and transmission of ground water. Because of the complex folding and faulting, they usually cannot be distinguished from each other in drillers' logs. Water is contained in joints which are commonly widened by solution in the massive beds, in fracture cleavage in the shaly beds and in openings along faults and bedding planes. Springs are common in these limestones and their number is related to the intensity of deformation of the rocks. The beds are more strongly deformed and the number of joints increases from north to south. Correspondingly, the number of springs is greater and yields

from wells are reported to be larger in the southern part of the limestone belt than the northern. The yield of 8 wells averages 7 gpm and ranges from 1 to 30 gpm. The depth of 7 wells averages 123 feet and ranges from 30 to 250 feet. The depth to water level in these wells averages 15 feet and ranges from 3 to 36 feet.

Two chemical analyses of water from well G 512 which taps the Manlius and Coeymans limestones in Greene County are given in table 4. The analysis for the sample taken October 3, 1952, together with 12 other analyses of water from the Rondout and Manlius limestones, and Helderberg group in Greene and adjacent counties, show a hardness ranging from 128 to 820 ppm and averaging 358 ppm. The hardness is chiefly carbonate hardness. In four of the analyses the iron concentration is more than 0.3 ppm.

Glenerie limestone (of Chadwick, 1908) and Esopus siltstone.—On plate 2, the Glenerie limestone and Esopus siltstone are mapped together. Their outcrop trends northeast, parallel to that of the adjoining limestones described in the previous paragraphs. The Glenerie and Esopus overlie the Helderberg group. In the northern part of the County, the outcrop is uniform in width, averaging several hundred feet, but in the central and southern parts the outcrop is complicated and irregular in width. The formations locally form ridges owing to their generally resistent character.

The Glenerie limestone (of Chadwick, 1908) is equivalent in age to the Oriskany sandstone of central New York. It is typically a siliceous limestone; at Alsen, it is almost solely chert. The Oriskany and Glenerie of the northern part of the County have a total thickness of about 6 feet; the true Glenerie at Leeds is 9 to 10 feet thick, and at Alsen it is 20 feet thick. The Esopus overlies the Glenerie with a gradational contact and is composed of siltstone and fine sandstone. The Esopus siltstone in the Leeds Gorge, as estimated by Chadwick (1944, p. 92), is 250 feet thick, and this thickness is believed to be about the same throughout the County. Both formations are characterized by joints, and the Esopus has well-developed fracture cleavage.

In the Glenerie limestone and Esopus siltstone, ground water occurs largely in joints. The range in yield of 4 wells is from 5 to 22 gpm, and the average yield is 10 gpm. This compares with an average yield of 8 gpm for 4 wells in the Esopus siltstone in adjacent Schoharie County. The range in depth of 5 wells is from 77 to 270 feet.

Chemical analyses of water from two wells in the Esopus siltstone are given in table 4. The hardness is 160 and 230 ppm, the dissolved solids 299 and 368 ppm, the sulfate content 41 and 95 ppm, and the iron content about 0.3 ppm.

Schoharie grit and Onondaga limestone.—The Schoharie grit and Onondaga limestone, which are mapped together on plate 2, underlie a narrow area extending from the northern to southern borders of the County. The area lies close to the towns of Limestreet and Leeds, and is west of and similar in extent to the belt underlain by the Helderberg, Manlius-Rondout limestones. The Schoharie grit and Onondaga limestone locally form conspicuous ridges.

Although the Schoharie grit is a sandy limestone in its type area, in Greene County most of it is a shaly limestone which Goldring and Flower (1942, p. 681-686) have described as the "Leeds facies". The Onondaga is a purer limestone, in places crystalline. Both contain seams of chert. The Schoharie grit is a drab brown whereas the Onondaga limestone is light to blue gray. In Greene County each formation is believed to be approximately 80 feet thick. At places, the Schoharie has well-developed fracture cleavage. The Onondaga is characterized by a well-developed system of joints.

In available well logs, it has not been possible to distinguish the Schoharie grit from the Onondaga limestone, and no records were collected of wells known to obtain water ex-

clusively from the Schoharie grit. Like the other massive limestones, the Onondaga contains water principally in joints and bedding planes which have been enlarged by solution. Broad solution channels, connected with sinkholes, make extensive underground drainage systems, and commonly form springs. However, because of erratic distribution of the joints, and because of variation in size of the solution channels, the yields from springs and wells vary considerably. Yields of 9 wells obtaining water from the Schoharie and Onondaga range from 0.7 to 40 gpm. The author visited several springs in August, 1947 and estimated the discharge from one, G 11Sp, at 20 gpm. The others had comparatively small yields. (See table 3.) The relatively large yield of several of the wells indicates that these are better aquifers than any of the underlying hydrologic units in the County, although the erratic distribution of fractures and solution channels makes the success of any new well somewhat uncertain.

The quality of water in the Schoharie and Onondaga is shown by two analyses in table 4. The sample for well G 552, which reportedly penetrates the Onondaga limestone alone, has a dissolved solids content of 185 ppm and total hardness of 92 ppm. Both of these values are unusually low for a water from a limestone formation. Perhaps the water actually comes from the Schoharie grit. Six additional analyses are available for adjacent Albany and Schoharie Counties. The iron concentration ranges from 0.03 to 0.45 ppm. The hardness ranges from 92 to 380 ppm and averages 256 ppm. It is mostly carbonate hardness. Sulfate is less than 70 ppm in all samples analyzed.

Bakoven shale.—The Bakoven shale (pl. 2) crops out in a long, narrow belt immediately west of the Schoharie and Onondaga formations. In the southern part of Greene County, the Bakoven shale underlies a valley between the Hoogeberg on the west and the terrace formed by the Onondaga limestone on the east. In the northern part of the County the formation is more resistant and underlies hills or benches on the dip slope of the Onondaga.

The Bakoven is a fine-grained fissile shale. It is mostly black in color, although gray shale is intercalated with the black shale in the northern part of the County. The shale is generally incompetent and exposures are uncommon. Where observed, the Bakoven is crumpled and slickensided. The thickness is about 140 to 200 feet in Green County. The Bakoven shale probably is a poor water-yielding formation and unlikely to yield appreciable quantities of water except in areas where relatively resistant beds are fractured. None of the wells or springs visited in Greene County obtain water from the Bakoven. Chadwick (1944, p. 103) reports that a well in Ulster County, near Veteran, encountered a little natural gas in the Bakoven shale. The shale contains pyrite, and accordingly any ground water obtained might contain hydrogen sulfide locally.

Mount Marion formation.—The Mount Marion formation underlies a relatively broad north-south belt (pl. 2) approximately equal in area of outcrop to that of the entire sequence of limestones and shales west of the Deepkill and Normanskill unit. In the southern part of the County the belt underlain by the Mount Marion formation is about a mile or less in width northward to the vicinity of Leeds. North of Leeds the belt widens and near the northern border of the County it is between 3 and 4 miles wide. Unlike the formations to the east which make linear ridges, the Mount Marion formation forms numerous rounded hills. These hills are higher than the limestone ridges to the east. The Mount Marion formation is exposed at High Falls on Kaaterskill Creek and in Timmerman Hill, Vedder Hill, Potic Mountain, and others in the eastern part of the Hoogeberg.

The Mount Marion consists of gray silty shales, which break down into small chips, and gray but brown-weathering sandstone and siltstones. In the upper part, thick sandstones predominate and form massive ledges. The formation is thickest in northern Greene County, 1,100 feet near Medway, and is about 700 feet at Potic Mountain. The beds have a gently west-

ward dip. Within the formation are zones of contorted rock referred to as "storm rollers" (Chadwick, 1944, p. 111). Although concretionary in appearance, they were probably formed by slumping of deltaic sediments before they became thoroughly consolidated. Marine fossils occur in some shale and sandstone beds.

Included with the Mount Marion formation on plate 2 is the so-called Stony Hollow sandstone member of the Marcellus shale (Cooper, 1943, p. 247). It has not been possible to distinguish this member from the overlying shales and sandstones of the Mount Marion in the well logs available. Lithologically it is described as a fine calcareous sandstone, dark gray when fresh and weathering to a light gray. The thickness is estimated to be about 80 feet west of Catskill and about 100 feet in the vicinity of Leeds and Climax.

Water occurs in fractures in the Mount Marion formation. Bedding planes are tight and the thick beds of sandstone are well cemented. Hence, there is little opportunity for storage and movement of ground water except in the strong vertical joints that cut some of the thinner beds. Available records indicate that the Mount Marion may have the smallest yield of the consolidated rock formations. The range in yield of 16 wells is from less than 1 to 12 gpm and the average yield is 3 gpm. Four of the wells were reported to have no appreciable yeild. The range in depth of 18 wells in this formation is from 28 to 480 feet and the average depth 152 feet. The depth to the water level averages 20 feet and ranges from 7 to 50 feet.

The chemical quality of water from Mount Marion formation is relatively good, as indicated by 4 analyses given in table 4, and by 3 others for wells that obtain water from the Mount Marion in Albany County. The hardness in the 7 analyses ranges from 44 to 280 ppm and averages 142 ppm. Dissolved solids are from 100 to 360 ppm, bicarbonate from 65 to 317 ppm, and sulfate from 11 to 62 ppm. Iron exceeds 0.3 ppm in only 2 of the analyses.

Ashokan formation.—The Ashokan formation crops out west of the Mount Marion formation in a broad area extending from the northern to the southern border of the County. The outcrop pattern of the Ashokan formation is similar to that of the Mount Marion in that it broadens in the north as the formation thickens (pl. 2). In the southern part of the County the Ashokan formation is exposed on the west slope of the Hoogeberg, and in the extreme northern part it underlies a hilly area nearly four miles wide. The Ashokan is a resistant formation and forms hills that are part of the foothills of the Catskill Mountains.

The Ashokan formation consists of alternating sandstone and shale and is the base of a thick series of nonmarine deposits. The sandstone is often used for flagstones and is gray, arkosic, and laminated. Some of the sandstones are irregularly crossbedded indicating deposition in shifting currents. The shale is olive green and weathers to a rust color. The thickness of the Ashokan formation in southern Greene County is about 300 feet, along Catskill Creek it is about 275 feet, and in northern Greene County it ranges from 250 to 350 feet. The Ashokan formation is distinctly bedded, and the strata have a low westerly dip. The sandstones are cut by strong joints and the shales generally are closely fractured and are blocky in appearance.

The Ashokan formation is a somewhat better water-bearing formation than the Mount Marion. The yield of 20 wells ranges from 0.25 to 33 gpm and averages 8 gpm. The depths of these wells range from 27 to 528 feet and averge 100 feet. The available data do not suggest a close correlation between yield and depth of well. Water levels are generally deeper than in some of the less resistant formations which erode to form lowlands. In 10 wells, water levels had an average depth of about 60 feet below the land surface.

Only two analyses of water (table 4) are available for the Ashokan formation. The

water has a lower average concentration of most constituents shown than water from the Mount Marion formation. Iron concentration in one of the analyses is 0.6 ppm, but other constituents are present in moderate amounts and the waters probably are satisfactory for most uses.

Catskill formation.—The Catskill formation underlies about five-sixths of Greene County (pl. 2). The area of outcrop extends from the outcrop of the Ashokan formation westward to the western border of the County. The eastern edge is between 1 and 2 miles east of the towns of Greenville, South Cairo, and Palenville, and lies along a curve roughly paralleling the course of the Hudson River. The Catskill rests with gradational contact on the underlying Ashokan formation. It is the youngest consolidated-rock formation in the County. It underlies and forms the Catskill Mountains and much of the foothills.

The Catskill formation consists of a series of red, green and gray shales, red sandstones, and gray sandstones. These rocks have been subdivided by Chadwick (1944, p. 112-139) but the units cannot be recognized with any degree of certainty except in the Catskill front. As the same types of lithology persist throughout the whole section, it is considered a unit and designated the Catskill formation in this report.

The various lithologic types have been discussed by Mencher (1939), who has divided them into two main groups: graywacke with associated conglomerate, and red-colored sediments. The graywacke is poorly sorted and crossbedded. The conglomerate contains well-rounded pebbles in a groundmass of smaller angular fragments. Mencher states that the color of the graywacke and associated conglomerates varies from light to dark gray and from greenish to bluish. The dark-gray rocks are finer grained and somewhat weathered. The light-gray rocks are commonly rich in calcite. The greenish rocks have considerable chlorite and, at some places, numerous small fragments of green shale. Mencher notes that the blue sandstones appear to be hardest.

The red sediments generally are somewhat finer grained and the larger grains are more rounded. The red color is due to hematite, which occurs as a cement around the grains and as small aggregates. The total thickness of the Catskill in Greene County is believed to be about 5,500 feet. The lithology in this vast thickness is extremely variable, and any well log or section reveals a complex alternation of gray sandstone and red shale or sandstone.

In addition to the indicated lithology, three other rock types have been observed locally. In the northern part of the County, tongues of marine shale have been found by Goldring (1943, p. 274). Several wells south of Durham and Oak Hill (G 243, G 232, and G 221) are reported to have encountered black shale interbedded with gray sandstones. This black shale is probably in more than one stratum. In this same area several wells drilled in the lower beds of the Catskill are reported to penetrate "hard white rock" which may be a basal conglomerate.

The Catskill is little deformed but is traversed by numerous joints, which are the most important structural feature in the occurrence and availability of ground water in this formation. Joints are relatively numerous in the resistant sandstones and conglomerates and ordinarily are open to considerable depth. Furthermore, many of the sandstones have substantial original pore space. The shales also are jointed, but in the shales the joints are generally more tightly closed. Accordingly, the sandstones are relatively permeable, and the shales are relatively impermeable.

Wells in the Catskill formation have been grouped according to the type of rock that seems to furnish most of the water to each well. For the commonest lithologic types, the average yields are as follows: gray sandstone, 20 gpm (48 wells); red sandstone, 19 gpm (12

wells); bluestone, 15 gpm (93 wells); and red shale, 14 gpm (45 wells). As might be expected, the higher yields come from sandstone and the lower yields from the tightly cemented bluestone and shale. The average yield of wells in the formation as a whole is 17 gpm. No dry holes have been reported. These figures indicate that the Catskill formation is generally a better aquifer than any of the underlying bedrock formations. As the formation covers a wider area, more records have been collected for wells in the Catskill than in the other bedrock aquifers, and the data may be correspondingly more representative.

For the Catskill formation as a whole, the depth of 157 wells ranges from 21 to 600 feet and averages 135 feet. Depth to water ranges from 0 to 285 feet and averages about 30 feet. The wide range in water level is attributable partly to the varied lithology and partly to the topographic relief. The Catskill formation underlies a deeply dissected terrain, and where the rocks are such that water can drain readily to nearby deep valleys, the water table is deep.

Many small springs and seeps issue from the Catskill formation but only a few are used for domestic supplies and were recorded for this report. Most of the springs are along the contact of permeable and relatively impermeable beds.

At many places the alternation of permeable with less permeable beds, the westerly and southwesterly dip of the strata, and the topographic relief all combine to produce flowing wells. Water in a dipping permeable bed overlain by impermeable beds is under hydrostatic "artesian" pressure and will rise in a well to a height approaching but somewhat below the altitude of the water level in the recharge area. If the top of the well is below this level, the water will flow at the land surface. In the Catskill formation, flowing wells are scattered widely and are not restricted to any one locality. (See wells, G 85, 86, 176, 181, 189, 237, 339, 351, and 527, table 6.) In addition, two flowing wells are recorded at Jewett and two more about a mile west of Hunter in the valley of Schoharie Creek. There are five flowing wells between East Durham and Norton Hill. However, at Maple Crest, there are six flowing wells in less than one square mile. In two or three nonflowing artesian wells in the same vicinity (G 190 and G 192), water stands within about three feet of the land surface. Pumping well G 190 at a rate of 45 gpm causes well G 192 to stop flowing, indicating that both wells obtain water from the same stratum.

Most of the flowing wells in the Catskill formation are in the mountains or in the hilly areas near the base of the mountains. However, well G 303, which flows in wet weather, is near the top of Indian Ridge, several miles east of the mural front. This is the easterly most flowing well in the Catskill formation.

Analyses of 17 samples of water from the Catskill formation in Greene County (table 4) show that the water is good, and generally softer than that from any other aquifer in the County. The hardness in the 17 analyses averages 65 ppm. In two analyses the hardness was 104 and 230 ppm; in all the others, less than 90 ppm. Essentially all is carbonate hardness. The greatest sulfate concentration is 68 ppm. In 10 analyses the iron concentration is less than 0.3 ppm. In the others, it ranges from 0.4 to a maximum of 1.5 ppm. The high value is recorded for only one well, G 347. Dissolved solids range from 61 to 305 ppm, but in most samples it was less than 150.

Unconsolidated Deposits

Unconsolidated deposits cover the bedrock almost everywhere in the County. They attain a thickness of 200 feet or more in a few places. Except for thin bodies of alluvium which underlie narrow banks along present-day streams, the unconsolidated deposits are glacial drift. The glacial drift is divided into two units (pl. 3), which constitute the end members of

a continuous series (Flint, 1947, p. 103) grading from unsorted deposits—till—in which particles ranging in size from boulders to clay are mixed together to well-sorted deposits—stratified drift—in which the fragments occur in beds with a rather narrow range of grain size. The stratified drift may be further divided into fine-grained deposits, such as clay and silt, and coarse-grained deposits, such as sand and gravel.

The unconsolidated deposits generally have quite different physical characteristics from the bedrock, and water is contained almost entirely in the original pore spaces between the grains. Wells tapping unconsolidated deposits have an extreme range in yield. For example, most till and clay deposits are relatively impermeable, whereas saturated beds of sand and gravel ordinarily are highly permeable and may yield large quantities of water to properly developed wells.

In the following paragraphs, the distribution, physical characteristics, and water-bearing properties of the principal types of unconsolidated deposits are discussed.

Till.—Till occurs throughout Greene County and is the predominant unconsolidated deposit in the area except in some of the valleys and beneath the terrace along the Hudson River (pl. 3). It assumes the following forms: ground moraine, which is a relatively thin, widespread layer of till; drumlins, which are elongated hills; and moraines, which are masses of till deposited at the edges of a glacier.

Till is common in the western two-thirds of the area in the Catskill Mountains, where it forms ground moraine and local morainic loops. The greater part of the fill covering the bedrock in the upper Batavia Kill valley and along the northern slopes of both the northeastern and central escarpments (fig. 2) consists of till. Large bodies of till occur in the Schoharie Creek valley upstream from Lexington, and in Gooseberry and East Kill valleys. Till is extensive in Durham, Greenville, and western Cairo Townships, as both ground moraine and drumlins and druminlike hills are alined northwesterly parallel to the mountain front, but in the western part of the town of Greenville, east of Catskill Creek, the axes generally trend northerly. The area in which drumlins are common extends east to the vicinity of Gayhead, and a few scattered drumlins occur north of Medway and Urlton in the extreme northeastern part of the County.

North and east of Medway, and in an area to the south including much of the Hoogeberg and Kalkberg, especially Potic Mountain and Vedder and Timmerman Hills, the glacial drift is thin and consists principally of till. Moraines have been described by Chadwick (1944, p. 194-195) in the vicinity of Cairo Round Top and Bethel Ridge.

Till consists of earth debris picked up by the glacier and deposited directly by it, either during its advance or at the time of melting. Thus it is essentially unsorted rock debris whose predominant characteristic is a wide range in the grain size of its constituent particles. The material generally is heterogeneous, but it commonly contains some lenses of sand or sandy clay that are relatively porous and permeable. The composition of the till in Greene County varies from place to place, corresponding to the lithology of the rocks cropping out in the immediate area in the path of the moving glacier. The thickness of the till ranges from a featheredge on the mountain slopes, where much bare rock is exposed, to more than 100 feet in the uplands and valleys. It is about 80 feet thick in the Hudson Valley.

The heterogeneous texture, dominantly fine grain, and compactness of most of the till in the County give it a low porosity and permeability. Most wells tapping glacial till are dug and are about 20 feet deep and 3 feet in diameter. Table 6 gives no yields for dug wells. The yield is generally not known because pumps are operated for only short periods and draw mostly on storage of water in the wells. However, a well in till that does not intercept at least

a small lens of sand will yield little water. Even so, many wells in till fail during dry seasons. Probably the maximum sustained yield to be expected from such a well is of the order of a few hundred gallons a day.

In the days of hand pumps and a minimum of sanitary facilities, this was enough water for household needs. If more water was needed for farm purposes, additional wells were dug. Now the demand for water has increased beyond the yield of most dug wells in till, resulting in their gradual abandonment. Of the approximately 650 wells visited in the course of this investigation, less than 30 were dug wells. This may not be a true representation of all wells, but it probably gives a general indication of the relative abundance of wells that are in active use. When new houses are built the general practice now is to drill, not dig, for water. Nevertheless, the dug well has the advantage of being less expensive to construct and, in some cases, may provide water of better chemical quality than deeper drilled wells. In the relatively impermeable till, the dug well is usually the only type practicable, as it provides a large infiltration surface and a large storage volume.

Most wells east of Lexington, in the upper part of the Schoharie Creek valley, pass through a considerable thickness of drift believed to be predominantly a clayey till. The deposits are referred to in drillers' logs as "hardpan". The till probably contains little water, as the wells obtain water from the underlying bedrock. Also, at Tannersville and Haines Falls, on the north fork of Schoharie Creek (Gooseberry Creek), wells pass through varying thicknesses of till before entering bedrock. In the valley of East Kill, which contains several moraines that are associated with drumlins in the eastern part, the till evidently is unlikely to yield adequate supplies of water. No wells in this valley are known to end in glacial drift, and some wells penetrate more than 100 feet of tight till. Along the south fork of Schoharie Creek and Vly Creek, the till may contain some water. However, it is not tapped by wells perhaps because it is thin, and gravel or other permeable rocks are accessible at relatively shallow depths.

Probably most wells dug in till obtain water from more permeable lenses of sand and gravel, either enclosed in the till or lying at its base. Such lenses, if below the water table, transmit water to a well from a much greater area of till than could be exposed in the walls of the well. Locally, a little gravel occurs between the base of the till and the bedrock surface. For example, well G 241, about one mile west of Cornwallville, passed through 34 feet of till and obtained water in a thin lens or bed of gravel beneath the till.

In plate 1, the lower figure at each well designation is a depth figure. Where followed by the letter "R", it signifies the depth to bedrock in feet below land surface. Thus, an indication of the thickness of the overburden may be obtained from the map and it is possible to determine, in a general way, where the overburden is tapped in preference to the bedrock. For example, in the townships of Durham, Greenville, and Cairo, wells may penetrate 100 feet or more of glacial material, largely till, but few wells obtain water from the till. Along the northeastern boundary of the County and in much of the Hoogeberg and Kalkberg, the depth to bedrock is less than 20 feet at most places. In this area, wells are usually cased through the till and obtain water from the bedrock.

Chemical analyses were made of water collected from four wells believed to tap till (table 4). The mineral constituents in these water samples range widely and are probably representative of the wide range in lithologic composition of the till in Greene County. In the four analyses, the dissolved solids range from 66 to 874 ppm. In two analyses of water from till in the Catskill Mountains (wells G 4 and 57), hardness is 48 and 34 ppm and the iron concentration is 1.0 and 1.5 ppm. In two analyses of water from till in the northern and eastern parts of the County (wells G 233 and 413), hardness is 480 and 230 ppm and iron concentration 0.2 and 0.06 ppm.

Clay and silt.—In general, clay and silt are not water bearing. In Greene County, clay and silt occur widely in small strata or lenses interbedded with sand and gravel or with deposits of till. However, there are five extensive bodies of the stratified drift that are composed chiefly of clay or clay and silt. The material of these bodies is the finer grained rock material that was washed into and deposited in the quiet waters of glacial lakes presumably impounded behind dams of ice or of till. These five bodies are along the Hudson River, and at one place each in the valleys of Schoharie Creek, Batavia Kill, Catskill Creek, and Kaaterskill Creek. They are not distinguished from the other deposits of stratified drift on plate 3.

The largest body of clay and silt underlies the terrace along the Hudson River. It extends almost continuously along the river throughout the length of the County, and is as much as four miles wide between Athens and Coxsackie. The clay and silt were deposited in thin, even, essentially horizontal laminations. The deposits once underlay and formed a continuous, nearly level plain. At present, from Catskill south to the County line, this plain has been fairly well dissected, but between Athens and Coxsackie extensive flats remain. Athens Flat, along the West Shore line of the New York Central and east of U. S. Highway 9W, is perhaps the largest.

Well logs show that the underlying bedrock surface is comparatively irregular. From Catskill south there is no particular pattern to the irregularities, but west of Coxsackie a series of wells along Route 9W suggest the presence of a buried bedrock channel whose bottom is generally more than 100 feet deep, and has a maximum depth of at least 165 feet. This deep trench was carved out of the Deepkill and Normanskill shales, and it seems to lie parallel to and close to the base of the Kalkberg. It begins at Flint Mine Hill and apparently continues northward beneath Route 9W, and extends beyond the County. Unfortunately the unconsolidated deposits that fill this depression are chiefly clay and silt, which produce relatively little water (see logs of wells G 417, G 418, G448, and G 451 in table 5). However, thin beds of sand and gravel apparently intervene, at least locally, between the fine-grained deposits and the bedrock. For example, wells G 418 and G 451 are reported to obtain yields of 20 to 30 gpm from beds of sand and gravel.

A second, narrow but fairly long body of clay and silt occurs in the valley of Kaaterskill Creek in the northeastward-trending portion of its lower course east of the Hoogeberg. Where Kaaterskill Creek turns abruptly eastward, the body of fine-grained deposits continues northward following the depression east of Vedder Hill, and extends to the valley of Catskill Creek at Leeds. This body seems to occupy the lower portion of an old valley of Kaaterskill Creek (now abandoned in the northern reach adjacent to Vedder Hill). Few wells are known to penetrate these deposits, but well G 552, near Leeds, passed through 144 feet of unconsolidated deposits, of which the lower 129 feet is clay, before reaching bedrock.

A small body of fine-grained deposits lies in the valley of Catskill Creek at Oak Hill in the extreme northern part of the County. Well G 228 is 74 feet deep and failed to encounter bedrock. The material penetrated by this well, and others in the vicinity not shown on the map, is at least 70 feet thick, and composed, at least in substantial part, of clay.

The lower reach of the valley of Batavia Kill, from its junction with Schoharie Creek upstream to Red Falls, also contains considerable fine-grained fill.

Finally, an extensive body of unconsolidated deposits occurs along the valley of Schoharie Creek from Prattsville to Lexington, a distance of about 8 miles. A large, if not predominant, part of these deposits is fine-grained material. (See, for example, log of well G 30, table 5.)

Particles of clay and silt are extremely small; thus, pore spaces, although numerous, are

small. Many fine-grained deposits contain considerable water in storage, but do not transmit water readily. Conversely, the clays locally constitute confining beds retaining water under artesian pressure. The clays here described in Greene County are less permeable than the till. Of the more than 600 wells visited in Greene County none obtain water from the clay and silt.

Sand and gravel.—In Greene County, stratified deposits consisting mainly of sand and gravel occur along the stream valleys (pl. 3). The thickest known bodies are in the valleys of Vly Creek and West Kill. Gravel, interbedded with clay and till, occurs in the valleys of Schoharie Creek and Batavia Kill, and in the upper part of the valley of Catskill Creek. Deposits of sand and gravel are present in the valley of Potic Creek, beneath the Sandy Plain and Leeds Flat areas in the Catskill Creek valley, in the glacial delta of Catskill Creek at Jefferson Heights and West Catskill, and beneath the Kiskatom Flats along Kaaterskill Creek. Recent alluvium occurs in many creek bottoms and in islands in the Hudson River. It is composed chiefly of fine sand and is of small extent and thickness.

Sand and gravel were deposited (1) as deltas at the margins of glacial lakes and (2) as outwash laid down chiefly by and in melt-water streams flowing away from the ice. The deltaic deposits thus occupy certain specific areas of relatively small extent. These deposits are relatively well sorted, and the pore spaces are open, resulting in a fairly high permeability. The grain sizes usually are progressively coarser in the direction of the delta heads. At the outer margin of the deltas the deposits grade into or overlie or interfinger with beds of clay and silt. Outwash deposits differ in lithologic characteristics because of differences in the velocity, volume, and load of the depositing streams, or differences in other conditions of deposition. The outwash deposits, as here considered, are either kames and kame terraces (Flint, 1947, p. 146-7) situated along the valley sides, or valley-train deposits that occupy the valley floors (Flint, 1947, p. 135). The kame and kame-terrace deposits are poorly sorted and irregularly stratified sand and gravel, as they were formed over and along the margins of stagnant ice that subsequently melted. In contrast, the valley-train deposits are well sorted. Because depositional conditions were varied and relatively complex, the character and consequently the permeability of the outwash deposits differ within relatively short distances, causing in some cases abrupt changes from coarse to fine materials. In addition, outwash deposits are known to occur locally overlain or underlain by till. In some places there is no sharp dividing line between the materials.

The deposits of sand and gravel generally are highly permeable. Hence, the deposits of sand and gravel are tapped by only a few wells. Furthermore, the relatively few records available show that only small yields have been obtained, and also that the wells are unscreened and not developed. The average yield of 26 wells reported ending in gravel is 29 gpm and of seven wells reported ending in sand is 16 gpm. The maximum water-yielding capacity of these deposits in Greene County is not known. From the records of wells, it is found that the drilled wells that tap them all draw water directly through the open bottom of the casing which is in the water-bearing bed. A proper screen would provide a much larger intake area which would increase the yield many times.

Numerous records show that wells have been cased through thick deposits of sand and gravel to end scores of feet lower in dense bedrock, which yielded but a few gallons a minute. This is unfortunate because the sand and gravel, at most places, are capable of yielding substantial quantities of water to properly constructed and developed wells. In areas where the deposits are favorably located for recharge from nearby streams, relatively large withdrawals of water can be sustained for long periods of time without excessive lowering of water levels.

The five available analyses of water for Pleistocene gravel (table 4) indicate that most mineral constituents are in small enough quantities that the water is satisfactory for general

use. Hardness ranges from 16 to 96 ppm. Iron concentration ranges from 0.10 to 0.9 ppm, and is less than 0.3 ppm in three of the five analyses. Sulfate does not exceed 8.0 ppm. The dissolved-solids content ranges from 44 to 213 ppm.

The following paragraphs describe ground-water conditions in the principal areas underlain by sand and gravel.

In the valley of Vly Creek (Halcott Township), wells are reported to penetrate about 45 feet of sand and gravel beneath about 50 feet of till. Well G 15 had a reported yield of 150 gpm sustained over a period of five hours. Other wells in this area, however, have smaller yields. Records of seven wells bottoming in and obtaining water from sand and gravel show yields of 2 to 12 gpm. Nevertheless, fairly large supplies of ground water probably can be obtained in this valley from properly developed wells.

According to Rich (1935, p. 86-87), the valley of West Kill, part of the Schoharie drainage, contains large moraines near its lower end and many small moraines on its flanks. Rich states that for one mile above and two miles below the town of West Kill, the bottom of the valley is filled by valley trains, but that the northern part of the valley is mantled by thick drift "having a smooth, overridden appearance"—presumably till. At West Kill, well G 40 in the axis of the valley, is reported to penetrate sand and gravel from 60 to 90 feet (table 5). A record for well G 33, about 1.5 miles north of West Kill, shows fine gravel from 90 to 109 feet. These wells are reported to yield 15 and 20 gpm, respectively. In the vicinity of Spruceton, wells G 35 and G 36 penetrate gravel or coarse sand beneath clay and are reported to yield 20 and 40 gpm, respectively. Thus, the prospects of obtaining substantial ground-water supplies from the unconsolidated deposits in the West Kill valley appear to be good.

In the valley of Schoharie Creek near the junction with Little West Kill, outwash gravel is interbedded with lake clay and with till. The log of well G 30 (table 5) shows 70 feet of gravel at the top, then 110 feet of quicksand and clay, and four feet of gravel at the bottom. This well is reported to yield 250 gpm, and to have flowed at the time it was drilled. At Lexington, there is a similar sequence of deposits. Two wells (G 28, G 47) penetrate two layers of gravel separated by a 15-foot bed of clay. Both wells obtain water from the lower gravel, reportedly at least 20 feet thick. Well G 28 has a yield of 25 gpm. A driven well immediately north of Lexington (G 43) probably obtains water from the upper bed of gravel. Thick beds of clay and till reported at places, as in the log of well G 31 (table 5), suggest that large supplies may not be obtainable in some places from the valley fill at Lexington.

In the headward parts of Schoharie Creek, particularly at Kaaterskill Junction and south in Stony Clove, there is more than 50 feet of stratified sand and gravel. (See records for wells G 56, G 103, table 6.) Well G 103 is reported to yield 30 gpm, and probably moderately large supplies of ground water could be developed at many places in this area. In the valley of the south fork of Schoharie Creek, from Kaaterskill Junction to Plaat Clove, deposits of sand and gravel are probably thicker than in the valley of the north fork, and may be equally as or more productive, but adequate well records are not available.

In the lower part of Batavia Kill valley, logs of three wells, G 11 (table 5) and G 12 and G 13, between Red Falls and Pratt Rocks, show 10 to 30 feet of red gravel, 70 to 138 feet of blue clay, and, at the bottom, 10 feet or more of water-bearing sand and gravel. Two of the wells flow and are pumped at about 4 gpm. Well G 13, the nonflowing well, yields 75 gpm. The part of the valley of Batavia Kill east of Red Falls contains water-bearing gravel at places. Well G 152 reportedly penetrates about 20 feet of sand and gravel resting on bedrock. In other parts of the upper valley, the fill is mostly sand. A large delta deposit is present at Windham and several small deltas occur between Ashland and Windham, but they are all thought to be above the water table and not potential ground-water reservoirs. East of Windham, gravel

deposits also occur in the upper part of the Batavia Kill valley, but most of these are also above the water table.

In the valley of Huntersfield Creek, well G 7 passes through 230 feet of unconsolidated material logged as sand, clay, and gravel, and reportedly yields 40 gpm. This well is near the front of a delta, and other wells put down in this delta probably would have good yields also.

In the eastern and northeastern parts of Greene County east of the Catskill Mountains, where ice was much thicker, the ice probably covered the lowlands at the time the glacier was melting from the Catskill Mountains. In the town of Durham, small bodies of sand and gravel were deposited between the flanks of the mountains and glacial ice. Subsequently these deposits were buried beneath till, perhaps by a readvance of the glacier. For example, the log of well G 248 shows 35 feet of gravel overlain by 80 feet of till. In the area from Catskill Creek north along Potic Creek to the Newrys-Medway road, including the Cob Creek watershed, deposits of poorly sorted sand and gravel form kames and other features associated with a stagnating ice sheet. Most of these deposits are less than 20 feet thick (pl. 1), and they lie on a fairly smooth bedrock surface. From the vicinity of Cairo to Leeds, Catskill Creek flows across broad plains known as Sandy Plain and Leeds Flats. The only drilled well in this area, G 295 on Sandy Plain, obtains water from the bedrock, but the log shows 30 feet of sand and gravel. Driven wells, such as G 277 and G 294, in the same general area, obtain small supplies from sandy deposits. Accordingly, fairly good supplies of water probably could be developed in these plains, especially in the upstream portions near South Cairo.

Where the deposits are predominantly sandy and the water table shallow, drive points make satisfactory and economical wells. These are constructed by driving down a string of pipe, commonly 1¼ inches to 2 inches in diameter, with a screened drive point at the bottom. Such wells may be driven by a maul or by alternately raising and dropping a heavy weight suspended by a tripod. The depth to which such wells may be driven is limited by the resistance of the material, the friction on the pipe, and the chance occurrence of large boulders. Under favorable conditions 2-inch wells can be driven 100 feet or more in sand and fine gravel. Although the yield of individual wells is generally not great, they may be useful for small domestic and stock use, for testing shallow aquifers, and for the development of temporary water supplies. Where the water level is shallow, larger supplies can be obtained from gangs of drive points connected to a common pump.

In the valley of Kaaterskill Creek, extensive areas appear to be underlain by unconsolidated deposits. The largest of these is the Kiskatom Flats, west of Vedder Hill (pl. 1). No known wells actually tap these deposits, but several wells drilled into the bedrock of which G 524 is one, reportedly pass through gravel above the bedrock. If this gravel is thick and extensive, the area could doubtless produce large ground-water supplies.

A large delta lies along Catskill Creek east of Jefferson Heights. This delta has been divided into two parts by Catskill Creek, and the northern part extends several miles up the valley of Hans Vosen Kill. The material composing this delta is mostly sand and gravel that rests on older lake clays. No records of wells in these deposits are in hand, but where saturated with water, they might yield substantial quantities to properly constructed wells.

FLUCTUATIONS OF WATER LEVELS

Ground-water levels fluctuate as a result of withdrawals by wells and variations in natural factors—precipitation, evapotranspiration, and runoff. Local precipitation is the source of nearly all ground water in Greene County. However, only part of the rain and snow that falls

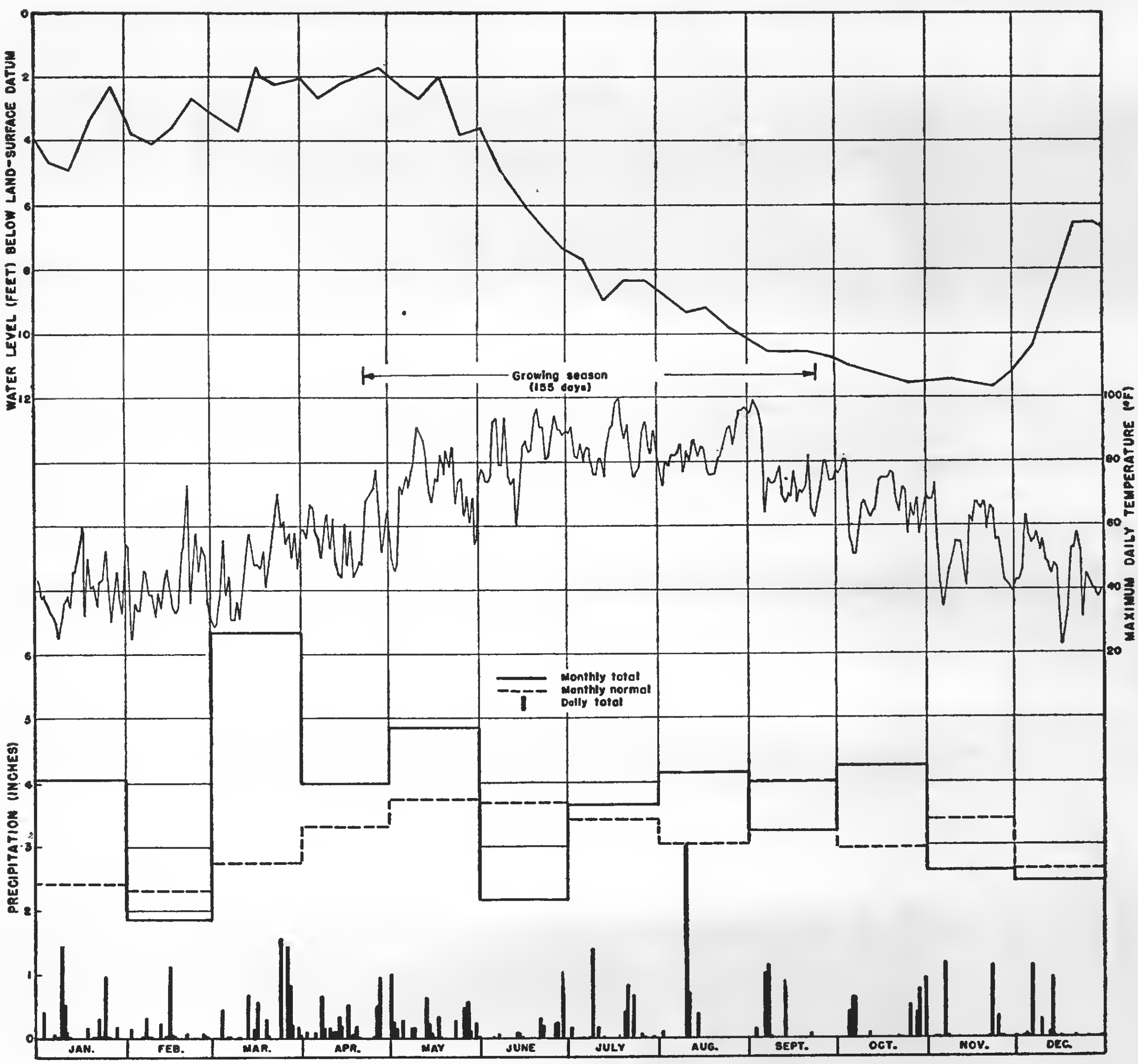

Figure 4.—Graph showing weekly water level in well G 1 near Coxsackie and daily air temperature and precipitation at Cairo for the year 1953.

percolates to the water table. A large part of the precipitation runs off directly in streams, evaporates, or is transpired by plants. The amount of precipitation that is absorbed by the ground (and only part of this reaches the water table) is affected by such factors as character of the soil and rock, shape of the land surface, amount and kind of vegetal cover, and amount of soil moisture present at the time of rainfall or snow melt. During the growing season vegetation draws heavily on the soil moisture, tending to prevent recharge of the ground water. High temperatures greatly increase evaporation rates; freezing temperatures, if sustained, freeze the ground, thus blocking infiltration and increasing direct runoff from rainfall or snow melt until such time as the frost melts.

All these factors influence the amount of recharge or of discharge at any one time and place. If the amount of recharge is greater, water levels rise; if the amount of discharge is greater, water levels decline. Thus, fluctuations of the water table indicate the current balance between recharge and discharge at the place of observation. Also, the position of the water at one time, in comparison with the position at a previous time, indicates the net change in ground-water storage in unconfined aquifers in much the same manner as changes in water level in surface reservoirs indicate net changes in surface storage.

The pattern and amount of the water-level fluctuations may be determined by measurements in observation wells. Periodic water-level measurements were begun in December, 1945 in a dug well believed to penetrate till, about two miles north of Coxsackie at the home of Magnus Andersen (well G 1). The well is occasionally used for domestic purposes, but only small quantities of water are withdrawn. In all cases, observations are made after many hours of nonuse, so that there probably is complete recovery of water level. Thus, the record accurately shows seasonal fluctuations and trends in relation to climatological and other factors. This record is generally representative of fluctuations of the water level in till, but it probably is not representative of fluctuations in wells that penetrate other unconsolidated deposits or bedrock.

Figures 4 and 5 present data correlating ground-water levels in observation well G 1 with air temperatures and with precipitation at Cairo, N. Y. Figure 4 shows details of rainfall and water-level fluctuation for the single year 1953. In these graphs, minor water-level peaks seem to coincide with periods of precipitation, especially in March, April, and May. Also in those months, the minor fluctuations are superimposed on a generally rising trend. There was little correlation with precipitation during the summer.

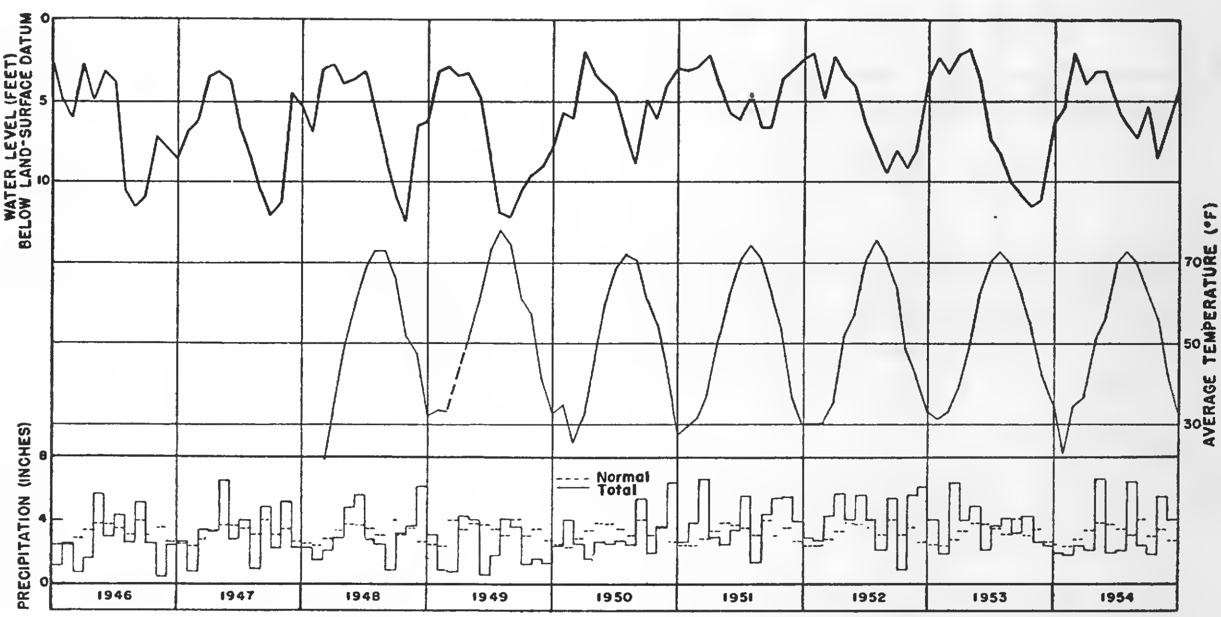

Figure 5.—Graph showing monthly water level in well G 1 near Coxsackie and monthly air temperature and precipitation at Cairo.

In figure 5, the dominant feature is the seasonal fluctuation, the water levels being highest during March or April of each year and lowest in September, October, or November. The declining portion of this seasonal fluctuation, which is observed in all observation wells throughout Upstate New York not affected by pumping, corresponds with the growing season, which is also the season of highest temperature. There is a suggestion that the summer water level is lowest during the hottest summers, but other factors may be contributing. The seasonal low is not closely related to minor fluctuations in precipitation. However, during extended dry periods, the water table may drop below the bottom of shallow dug wells and cause the wells to go dry. These wells might produce water throughout the year if they were deepened below the minimum level of the water table. The rising portion of the annual fluctuation usually commences shortly after the end of the growing season, when evapotranspiration losses are at a minimum and when a larger percentage of the precipitation reaches the water table. The rise continues until spring. The years 1950 and 1951 show a smaller seasonal fluctuation than previous years, because exceptionally heavy rainfall during the summer months of those years was enough to afford considerable replenishment to ground-water reservoirs even after evapotranspiration requirements had been satisfied. Figure 5 indicates that the levels in well G 1, for the period of record, rose each spring to approximately the same level as in the preceding spring, indicating that there was no pronounced overall tendency toward declining water levels.

SPRINGS

Meinzer (1923, p. 48) has defined a spring as a place where, without the agency of man, water flows from a rock or soil upon the land or into a body of surface water. Springs are numerous in Greene County and are most common in the Catskill Mountains and the Kalkberg. Nearly all are small roadside springs or small springs that supply farms and rural homes. Table 3 gives data on 20 springs that are considered to be representative. However, most of the springs in the County were not visited and are not shown on plate 1. Several springs, as at Cairo, Windham, and Hensonville (not recorded in table 3) produce enough water to be substantial public supplies in themselves or to serve as an auxiliary source. (See p. 34.)

Most springs flow under the force of gravity from openings in the rocks and are in effect an outcrop of the water table. They are either seeps which percolate from small openings in porous open material, such as sand or gravel, or streams which flow from joints or other openings in the rocks. Most of the springs in Greene County can be classed as *seepage springs* which occur at the outcrop of the water table in porous deposits, *fracture springs* which occur at the intersections of joints or bedding planes with the land surface, and *contact springs* which issue from the contact of an impermeable material with an overlying permeable material —for example, tight shale with porous sandstone.

Many fracture springs emerge from joints in the Manlius and Onondaga limestones. Spring G 12Sp (table 3), about three-quarters of a mile north of Limestreet, appears to issue from the intersection of a bedding plane and a joint at the base of a cliff formed by the Manlius and Coeymans limestones. It has a flow of as much as 25 gpm in dry weather. This spring may be associated with the small fault shown on the geologic map of the Coxsackie quadrangle (Goldring, 1943, map 1). Spring G 16Sp, about half a mile east of Cauterskill and a mile west of Catskill, issues from the Manlius. Spring G 17Sp, two miles north of Alsen along Route 9W, issues from a joint at the base of the Manlius near its contact with the Rondout limestone and gives rise to a brook. Springs G 11Sp and G 13Sp come from joints in the Onondaga limestone.

The formations of Middle and Late Devonian age are characterized by an alternation of relatively impermeable shale and open and porous sandstone. In areas underlain by these

Table 3.—Records of selected springs in Greene County, N. Y.

Location: For explanation see section "Purpose and scope of investigation". Altitude above sea level: Approximate altitude from topographic map. Use: Dom, domestic; Com, commercial

Spring number	Location	Owner	Altitude above sea level (feet)	Principal aquifer	Use	Remarks
G 1Sp	12V, 1.8S, 1.4E	D. Faulkner	1,960	Pleistocene deposits	Dom	Owner reports, "always good flow". Temperature 42°F, October 10, 1945.
G 2Sp	12V, 1.6S, 1.5E	Marshall Bouton	1,980	Pleistocene gravel	Farm	Reported yield is 12.5 gpm, sufficient for 90 head of stock and two houses.
G 3Sp	12V, 2.7S, 1.3E	J. J. Leibson	1,820	Pleistocene deposits	Dom	Owner reports adequate supply for household.
G 4Sp	12V, 0.5S, 9.2E	R. Rice	1,400	Catskill formation	Dom	Supplies boarding house of 20 guests in summer.
G 5Sp	12V, 1.8N, 11.1E	Viola Shaw	2,200	do.	Dom	Estimated yield 6 gpm; spring supplies about 80 guests in summer.
G 6Sp	12W, 3.8N, 0.8E	G. W. Osborne	1,560	do.	Com	Supplies about 300 guests in summer.
G 7Sp	12W, 1.4N, 3.2E	Albert Ising	2,600	do.	Dom	Owner reports adequate supply for household.
G 8Sp	12W, 8.6N, 8.6E	John McIntyre	500	Pleistocene deposits	Dom	Supplements wells in supplying summer camp. Chemical analysis given in table 4.
G 9Sp	12W, 3.8S, 11.1E	Catskill House, Inc.	2,400	—	Com	Reported yield is 21 gpm; supplies about 300 guests in summer.
G 10Sp	12W, 7.5S, 9.1E	Police Recreation Center	2,300	Pleistocene deposits	Com	Supplies up to 400 guests and swimming pool in summer.
G 11Sp	12X, 5.9N, 6.6E	Unknown	260	Onondaga limestone	Farm	Yield estimated 20 gpm, August 29, 1947.
G 12Sp	12X, 4.5N, 6.9E	Unknown	162	Manlius limestone	Dom	Roadside spring. Yield measured 24 gpm, August 29, 1947.
G 13Sp	12X, 3.7N, 6.7E	Unknown	240	Onondaga limestone	Dom	Small roadside spring.
G 14Sp	12X, 1.8N, 5.2E	E. N. Gonnerman	190	Pleistocene gravel	Farm	Water piped to house and barn from four adjacent openings; owner reports never dry.
G 15Sp	12X, 1.5N, 5.9E	W. W. Travis	326	—	Farm	Temperature 47°F, October 3, 1945. Owner reports adequate supply for household and 20 stock.
G 16Sp	12X, 2.2S, 5.7E	H. S. Moon & Son Dairy	100	Manlius limestone	Farm	Southeast-dipping beds are mostly concealed by concrete. Yield is small.
G 17Sp	12X, 4.7S, 4.6E	Unknown	200	do.	Dom	Small roadside spring. Water emerges from intersection of joints and bedding planes.
G 18Sp	12X, 2.5S, 3.5E	Louis Oettlin	300	Mount Marion formation	Dom	Yield measured 1.5 gpm, September 25, 1945. Well also used for household.
G 19Sp	12X, 0.8S, 1.0E	Louis Scarfi	375	Pleistocene deposits	Dom	Supplies boarding house of 24 persons in summer.
G 20Sp	12X, 1.9S, 4.75E	Simon Riesse	90	Esopus shale	Dom	Flow from this spring reported dependable. One of four springs on Riesse property; two others have intermittent flow from limestone, another has continuous flow from glacial deposits.

rocks, contact springs occur along bedding planes between the beds of shale and sandstone. Springs G 5Sp and G 6Sp, in the Catskill formation and spring G 18Sp in the Mount Marion formation, are examples of contact springs. (See table 3.) On many hillsides in the Catskill Mountain valleys a series of such springs may occur all at about the same altitude, and evidently along a contact.

In deposits of Pleistocene age, most of the springs appear to be seepage springs and are situated in valley areas along or near stream courses. In table 3, seepage springs are represented by records for G 1Sp, G 2Sp, G 3Sp, G 10Sp, G 14Sp, and G 19Sp.

In the Kalkberg, springs are discharge points for subsurface drainage from sinkholes in the soluble limestones. Commonly the springs issue from joints or open bedding planes at the foot of slopes, and the associated sinks are on the crests of ridges above. Several springs may serve as the outlet for one sink, the higher outlets flowing in wet seasons when the lower outlets are unable to handle the entire discharge. At Cauterskill, a depression along the crest of a double ridge on Simon Riesse's farm ends in a sink developed along nearly vertical bedding planes of the Becraft limestone. Two possible outlets for this sink, one along the Coeymans and Manlius contact to the south and the other in the Alsen limestone to the west, were both dry when examined in August, 1947, whereas another spring on the Riesse farm (See spring G 20Sp, table 3) had a good flow at that time. At spring G 16Sp, there is a sink on the hill above developed along joints in the Kalkberg limestone. This sink probably connects not only with spring G 16Sp but also with smaller wet-weather springs.

One of the largest and most interesting sinks in the County is the Streeke sink, which is near a power-transmission line about three-quarters of a mile north of Van Luven Lake north of Alsen. This sink receives the drainage from a pond and from streams that extend nearly to Route 23A. It is developed in the Alsen limestone and is situated on the east side of an open valley apparently eroded chiefly from the Esopus siltstone. The eye of the sink is not more than 1½ feet across, but when visited in December, 1947, it was receiving a stream about one foot wide and one inch deep without overflowing. There is no obvious nearby outlet for this flow. However, some of the water may discharge from spring G 17Sp, as Chadwick (1944, p. 177) evidently thought. It is probable that the drainage from the sink passes along joints and is not influenced by the thrust faults shown in Chadwick's diagram.

Water flowing through cavernous limestone is not purified by filtration, and therefore springs issuing from it are not always safe for drinking, especially when, as in at least one case in Greene County, the sinks that feed them are used as rubbish dumps. Many springs at the base of the Manlius limestone occur along roadsides and accordingly may present a sanitary problem because summer vacationists are prone to consider all spring water safe.

UTILIZATION

Ground water is used extensively in Greene County, but practically all the many individual supplies are small. Thus, the total amount of daily withdrawal is modest, perhaps averaging about 2 million gallons. Water supply for stock and for domestic use on farms and other rural homes not served by municipal systems is obtained almost exclusively from wells and springs, and ground-water consumption for these uses is estimated to exceed that for all other uses in the County combined. Commercial establishments, including a relatively large number of tourist resorts which are operated seasonally, are the second largest consumers of ground water. The County is not heavily industrialized. Although half the public supplies depend on ground water at least as an auxiliary source of supply, less than 10 percent of the average municipal pumpage of approximately 1,700,000 gallons daily is ground water.

Domestic and Farm Supplies

Ground water is the principal source of water supply for 1,606 farms in Greene County (Department of Commerce, 1950), for rural homes, and for smaller villages. Approximately half the population resides in areas not served by a municipal system and obtains water supplies almost exclusively from wells and springs. About 74 percent of the individual springs and wells listed in tables 3 and 6 are used for domestic or farm purposes. The domestic uses of water include drinking, cooking, washing, and sanitation; these needs are adequately supplied by wells of small yield. Water for cattle and other farm animals is similarly obtained, although commonly a farm has a well for domestic purposes and one or more springs for stock. Dairying is an important part of the County economy. There are many orchards in the Hudson Valley and it is reported that some ground water is used for spraying the trees. The average daily consumption from domestic or farm wells and springs is generally less than 500 gallons.

Industrial and Commercial Supplies

Inasmuch as Greene County is not heavily industrialized, water is not extensively used for industrial purposes. Manufacturing establishments are located principally at Catskill, Athens, Coxsackie, and West Coxsackie, their development favored by location on the Hudson River and later by the building of the West Shore Line of the New York Central Railroad. Most of these establishments obtain water from the towns named, all of which have surface-water supplies. Considerable ground water is used by cement companies and other quarrying concerns in the County. Three of the largest quarries are in the limestone hills near Alsen and Cementon. Both towns are supported entirely by the cement industry. At Cementon, the source of supply is a spring-fed reservoir half a mile west of the plant. Some water is delivered to employees of the company for domestic purposes, but about 80 percent of the total daily pumpage of several thousand gallons is for quarrying.

Greene County contains a sizable and attractive part of the Catskill Mountains, and catering to the tourist trade is one of the largest means of livelihood in the County. The principal resort district is in the eastern part of the Catskill Mountains in such towns as Maple Crest in the valley of Batavia Kill; and Haines Falls, Tannersville, and Hunter in the valley of Schoharie Creek. Other resorts are at Palenville at the foot of the mountains, and near East Durham and Greenville north of the mountains. Although not all the resort wells were visited, it is believed that records were obtained for wells at most of the larger resorts. Of the 54 wells whose use is classed as commercial, 50 serve hotels, boarding houses, and tourist houses that cater chiefly to summer visitors. Total consumption at 35 of these resorts is estimated at 130,000 gallons per day in July and August. This figure does not include water for the seven known swimming pools. Three of these pools have a combined capacity exceeding 350,000 gallons. It is not known how often they are filled. Because the requirements may be large even though of short duration, some establishments have as many as five or six drilled wells and large storage facilities, and yet are short of water. Peak tourist and vacation demands occur at a time when water losses from evaporation and transpiration are at their maximum, and when ground-water recharge is low.

Public Supplies

Of the 10 public water systems in Greene County, four use ground water wholly or in part. However, all of these are in small communities. There are about 35 unincorporated settlements in the County that do not have any public water system.

Catskill.—The water for the town of Catskill (population 5,392) is obtained entirely from surface-water sources. Water is taken from the West Branch of Potic Creek which has a drainage area of about 14½ square miles above the dam two miles south of Earlton. The reservoir, in use since 1930, has a storage capacity of 220 million gallons, about a 7-month supply. Another reservoir having a capacity of four million gallons may be used as an auxiliary source if needed. Water treatment includes the use of alum as a coagulant, aeration, filtration, and chlorination. The daily consumption averages about 900,000 gallons. Residents of Leeds and Jefferson also are served by the Catskill system. In the summer, the maximum population served is about 8,000.

Coxsackie.—Coxsackie (population 2,722) is supplied from a reservoir on a tributary to Coxsackie Creek situated northwest of the village at Roberts Hill. Water is distributed from the reservoir by gravity. The maximum daily consumption is about 450,000 gallons, and the average daily consumption is about 300,000 gallons. About 20 percent is used by industries.

Athens.—Athens (population 1,545) obtains water from Hollister Lake, 5½ miles northwest of the village. Water is pumped to a concrete reservoir near the village from which it is distributed by gravity. The maximum daily consumption is about 300,000 gallons, and the average is about 175,00 gallons. About 20 percent is used by industries.

Cairo.—Cairo (population 800) is supplied by several springs and a brook two miles northwest of the village, which together feed two reservoirs of 11 million gallons capacity each. Distribution is by gravity. A well near the reservoir is pumped in dry seasons at the rate of about 15 gpm. The daily consumption averages about 60,000 gallons. In the summer the maximum population served is reported to be about 6,000.

Tannersville.—Tannersville (population 639) is supplied from a small brook, Schoharie Creek being an auxiliary source. Tannersville is primarily a summer resort, and the use of water is greatest in summer. Approximately 400,000 gallons per day is pumped during June, July, and August. The average daily pumpage in the remainder of the year is about 70,000 gallons.

Prattsville.—Prattsville (population 600) is supplied by an impounding reservoir on Huntersfield Creek northeast of the village from which water flows into a concrete collecting basin having a capacity of 40,000 gallons. Treatment consists of chlorination, and distribution is by gravity. An auxiliary source of supply is a drilled well 408 feet deep which is reported to yield 500 gpm. Daily consumption is believed not to exceed 80,000 gallons.

Hunter.—Hunter (population 526) obtains water from a small brook near the village. Consumption averages about 50,000 gallons per day.

Windham.—At Windham (population 600) a spring supplies about 105 families and a hotel. The system includes three reservoirs. Distribution is by gravity at most times, but in dry weather water is pumped from an auxiliary spring. The average daily consumption is believed to be about 35,000 gallons.

Hensonville.—Hensonville (population 250) is supplied by a group of five springs half a mile east of town. Water is collected in a small storage reservoir and distributed by gravity. Daily consumption is reported to be about 10,000 gallons.

Alsen.—Alsen has no public system serving the whole community, but about 150 persons are supplied from a well owned by a cement company (G 507). Water from this well is chlorinated, then pumped to an elevated wooden tank and distributed by gravity. The daily consumption is reported to be about 5,000 gallons.

QUALITY OF WATER

The chemical quality of ground water in Greene County varies considerably from place to place, depending largely on the water-bearing formation. Table 4 gives analyses of water from 47 wells and one spring. The total number of analyses is small, but at least two are available for each of the 10 main water-bearing units discussed in foregoing paragraphs. Most of the analyses are for water from the Deepkill and Normanskill shales, Catskill formation and Pleistocene gravel.

All but one of the samples were collected by the Geological Survey, and all but two of the analyses were made by the New York State Department of Health. The principal anions were determined for most samples, but the cations other than iron and manganese were not determined except in two analyses made by the Geological Survey. The results of the analyses are expressed in parts per million (ppm.) A part per million is a unit weight of a constituent in a million unit weights of water. For example, 1 ppm of iron is 1 pound of iron in a million pounds of water.

The bicarbonate concentration in 33 of 49 analyses was more than 100 ppm; in 17 analyses it was more than 200 ppm; and in five analyses it was more than 300 ppm. The greatest concentration was 522 ppm in one sample from the Normanskill shale (well G 477). The sulfate concentration in 13 of 44 analyses was more than 50 ppm, but only six of 44 analyses show more than 70 ppm of sulfate. The samples were low in chloride. In only five of 49 analyses was this constituent as much as 35 ppm. Samples from a few scattered wells had high chloride—180 and 205 ppm in samples from wells G 228 and G 233, respectively. Both these wells obtain water from deposits of Pleistocene age, but the reason for the high chloride concentrations is not known. Determinations of calcium, magnesium, sodium, and potassium were made for samples from only two wells—G 85 in the Catskill formation, and G 530 in the Mount Marion formation.

According to recommendations of the U. S. Public Health Service (1946) dissolved solids in drinking water used on common carrier preferably should not exceed 500 ppm, but if such water is not available, dissolved solids of as much as 1,000 ppm, "may be permitted". These standards are generally accepted for public water supplies. Two samples from wells tapping the Normanskill shale (G 456 and G 477) had a dissolved-solids content of 1,050 and 1,120 ppm, respectively, and a sample from the Coeymans and Manlius limestones (G 512) had 1,050 ppm. All the other samples from bedrock for which the dissolved solids were determined contained less than 500 ppm. Similarly, all but one sample from Pleistocene deposits had less than 500 ppm of dissolved solids. Water from well G 233, in till, had 874 ppm of dissolved solids.

The iron concentrations given in table 4 ranged from 0.03 to 20 ppm. In about half the samples it was more than 0.3 ppm. Some samples of water from four of the water-bearing units had at least 1.0 ppm of iron; namely, the Catskill formation, Deepkill and Normanskill shales, Mount Marion formation, and Pleistocene till. Manganese is commonly associated with iron but usually is present in water in smaller quantities. Eight of the analyses given in table 4 show a manganese concentration of more than 0.10 ppm. The Public Health Service recommends that iron and manganese together should not exceed 0.3 ppm.

Available analyses indicate that the hardness of ground water in Greene County is related to the geologic formations from which the water is obtained. Most of the 17 samples of water from the Catskill formation were soft. Only one sample, from well G 330, had a hardness of more than 120 ppm, which is an arbitrary threshold value for moderately hard water. In contrast, waters from the Deepkill and Normanskill shales and from the limestone formations were generally quite hard, many having a hardness of more than 300 ppm. The hardness

Table 4.—Chemical analyses of water from wells and springs in Greene County, N. Y.

[Analyses by New York State Department of Health unless indicated otherwise. Dissolved constituents given in parts per million.]

Well or spring number	Depth (feet)	Water-bearing formation	Date of collection	Iron (Fe)	Manganese (Mn)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (as NO_3)	Dissolved solids	Hardness (as $CaCO_3$) Total	Hardness (as $CaCO_3$) Carbonate	Hardness (as $CaCO_3$) Noncarbonate	Alkalinity (as $CaCO_3$)	pH
G 3	54	Catskill formation	10- 1-45	0.05	0.0	27	7.9	1.2	—	73	42	22	20	22	5.7
G 4	11	Pleistocene till	10- 1-45	1.0	.0	41	11	2.8	—	79	48	34	14	34	5.9
G 13	102	Pleistocene gravel	10- 2-52	.16	.06	156	6.2	8.0	—	165	60	60	0	128	7.4
G 15	29	do.	10-10-52	.10	.01	16	8.0	3.0	—	47	16	13	3	13	6.2
G 19	60	Catskill formation	10-22-45	.1	.0	18	2.5	1.8	—	61	26	15	11	15	7.0
G 20	16	Pleistocene gravel	10-22-45	.1	.0	21	4.7	.8	—	53	28	17	11	17	7.0
G 37	160	Catskill formation	10- 1-45	1.0	.10	134	2.0	2.2	—	142	76	76	0	110	7.4
G 43	23	Pleistocene gravel	10- 1-45	.5	.0	21	5.7	.6	—	44	28	17	11	17	5.7
G 57	17	Pleistocene till	9-25-45	1.5	.05	8.5	12	2.8	—	66	34	7	27	7	5.4
G 80	118	Catskill formation	1-17-46	.5	.0	73	68	1.8	—	84	46	46	0	60	7.1
G 85[a]	126	do.	9- 8-47	.26	.0	99	9.1	4.4	.1	111	44	44	0	81	7.8
G 132	80	do.	10-24-45	.1	.0	109	7.9	18	—	157	88	88	0	89	7.4
G 141	101	do.	1-10-46	.2	.01	104	6.1	1.2	—	119	80	80	0	85	7.8
G 147	120	do.	10-24-45	.5	.0	41	7.8	3.2	—	83	40	34	6	34	7.1
G 152	164	Pleistocene gravel	10-24-45	.9	.25	132	3.2	46	—	213	96	96	0	108	7.7
G 181	140	Catskill formation	10-24-45	.4	.0	117[b]	56	3.0	—	149	16	16	0	96	8.8
G 194	143	do.	10-24-45	.15	.01	161	9.1	46	—	250	52	52	0	132	7.9
G 207	125	do.	11- 1-45	.15	.0	88	17	4.6	—	129	86	72	14	72	6.8
G 228	74	Pleistocene deposits	9-30-52	.18	.40	229	0.2	180	—	496	84	84	0	188	7.6
G 233	19	Pleistocene till	11-16-45	.2	.0	256	62	205	—	874	480	210	270	210	7.6
G 261	130	Catskill formation	10-24-45	.4	.01	49	20	3.8	—	109	52	40	12	40	6.9
G 278	78	do.	11-14-45	.4	.01	34	14	1.6	—	85	42	28	14	28	6.8
G 287	50	do.	11-14-45	.2	.01	55	10	2.2	—	90	64	45	19	45	6.8
G 330	66	do.	10-31-45	.5	.20	260	52	1.4	—	305	230	213	17	213	7.9
G 347	57	do.	9-30-52	1.5	.01	112	32	4.8	—	193	104	92	12	92	6.8
G 353	132	Ashokan formation	12-20-45	.06	.0	234	27	1.6	—	244	160	160	0	192	7.6
G 393	84	Normanskill shale	12-12-45	1.7	.0	278	109	4.8	—	459	330	228	102	228	7.3
G 413	24	Pleistocene till	1-14-46	.06	.0	223	26	3.6	—	291	230	183	47	183	7.2
G 423	10	Pleistocene deposits	11-21-45	.03	.0	350	91	9.4	—	601	370	287	83	287	7.1
G 432	183	Mount Marion formation	9-29-52	.80	.08	317	42	1.0	—	338	190	190	0	260	7.4
G 437	110	do.	9-30-52	.14	.35	123	62	18	—	360	148	101	47	101	6.4

See footnotes at end of table.

Table 4.—Chemical analyses of water from wells and springs in Greene County, N. Y. (Continued)

Well or spring number	Depth (feet)	Water-bearing formation	Date of collection	Iron (Fe)	Manganese (Mn)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (as NO_3)	Dissolved solids	Hardness (as $CaCO_3$)			Alkalinity (as $CaCO_3$)	pH
											Total	Carbonate	Noncarbonate		
G 442	60	Ashokan formation	9-29-52	.60	.20	149	16	1.4	—	159	112	112	0	122	7.4
G 456	354	Normanskill shale	12- 5-45	20	.15	406[c]	76	4.8	—	1050	100	100	0	333	9.3
G 477	75	do.	9-29-45	1.0	.05	522	421	15	—	1120	260	260	0	428	7.7
G 495	264	do.	10-20-45	.1	.0	394	69	10	—	474	120	120	0	323	7.7
G 506	150	Deepkill shale	4- 5-45	8.0	.04	291	—	5.4	.09	—	290	239	51	239	7.4
G 507	190	do.	4- 5-45	.03	.08	277	—	12	—	—	320	227	93	227	7.4
G 510	68	do.	9-23-45	.2	.10	186	—	33	.09	—	470	153	317	153	7.3
G 511	74	do.	7-25-45	.4	.10	250	—	24	.09	—	510	205	305	205	7.4
G 512	104	Coeymans and Manlius limestones	7-25-45	.1	.0	224	—	5.0	1.8	—	236	184	52	184	7.2
G 512	104	do.	10- 3-52	.10	.13	209	499	35	—	1050	540	171	369	171	7.3
G 524	187	Catskill formation	9-20-45	.04	.0	189	7.0	16	—	232	24	24	0	155	6.9
G 530[d]	120	Mount Marion formation	4- -39	2.4	—	65	23	1.4	.6	100	44	44	0	53	—
G 552	175	Onondaga limestone	9-30-52	.35	.03	146	35	1.8	—	185	92	92	0	120	7.6
G 595	28	Mount Marion formation	9-29-52	.17	.11	148	43	2.8	—	213	96	96	0	121	7.3
G 605	77	Esopus siltstone	9-30-52	.33	.0	168	41	3.8	—	279	160	138	22	138	7.2
G 606	100	do.	9-29-52	.32	.04	190	95	15	—	368	230	156	74	156	6.9
G 609	128	Onondaga limestone and Schoharie grit	9-30-52	.45	.02	256	67	23	—	371	240	210	30	210	7.3
G 8Sp	—	—	11- 2-45	.15	.01	59	17	14	—	138	66	48	18	48	6.8

[d] Analysis by Gustav, 4510 50 Ave., Laurel Hill, Maspeth, N. Y.: Silica, 12; calcium, 20; magnesium, 4.0; sodium and potassium, 2.3.

[b] Includes 10 ppm of carbonate.

[c] Includes 47 ppm of carbonate.

[a] Analysis by U. S. Geological Survey, Quality of Water Branch; Silica, 7.9; calcium, 14; magnesium, 2.3; sodium and potassium, 24; fluoride, 0.2.

in water from these shales and from the Coeymans, Manlius, and Onondaga limestones ranged from 90 to 540 ppm. The hardness in water from the Pleistocene deposits also had a wide range (from 16 to 480 ppm). In 29 of the samples, some noncarbonate hardness, sometimes referred to as "permanent" hardness, was found, but it exceeded 30 ppm in only 12 of the 29 samples. Three samples from the Deepkill and Normanskill shales had a noncarbonate hardness of more than 100 ppm, and approximately half the total hardness in four samples obtained from the Deepkill shale was of the noncarbonate type. Most of the samples from the consolidated rocks were slightly alkaline (pH more than 7.0), but most of the water samples from the unconsolidated deposits were slightly acid on the pH scale.

For well G 512, analyses of water were made at two different times. Water samples collected in 1945 and again in 1952 appear to be quite different. Calcium or magnesium sulfate accretion appears to be large on the basis of alkalinity and hardness. Also, water from well G 512 apparently had only 5 ppm when sampled in 1945, and 35 ppm when sampled in 1952. The reason for the difference is not known. The possibility exists that the chemical quality of the water changed from a change in pumpage, local contamination, or some other condition.

In summary, the older rocks generally yield water of poorer quality. In the Deepkill and Normanskill shales, water has the greatest concentration of dissolved solids, and certain mineral constituents may be in quantities objectionable for most uses. In the unit extending from the Rondout limestone to the Onondaga limestone, inclusive, water is generally hard, and iron in about half the analyses is excessive. In the rocks extending from the Mount Marion formation to the Catskill formation, inclusive, the water is generally soft, and iron in a few analyses is excessive. For wells tapping unconsolidated deposits, water obtained from Pleistocene sand and gravel is commonly of better quality than that obtained from Pleistocene till or fine-grained deposits, and in many respects it is the water of best quality from any aquifer in Greene County.

TEMPERATURE

When water is used for cooling or air conditioning, its temperature is generally its most important characteristic. Water having a uniformly low temperature is desired. Regardless of the season, the ground-water temperature is about the same as the mean annual air temperature of the region (Collins, 1925, p. 98), and at depths greater than about 10 feet the annual range in temperature is slight. The mean annual air temperature in Greene County is about 49.5°F. The temperature of surface water reflects local atmospheric conditions and in streams in and near Greene County may vary during the course of a year from freezing to more than 80°F.

Ground-water temperatures listed in table 6 average about 47.5°F. An attempt was made to observe the temperature of the ground water at all wells visited, but at many places it was found impossible to obtain a reading before the water had passed through pipes or storage tanks. Many of these are in heated cellars or next to hot water pipes, and the temperature of the stored water is ordinarily higher (though in some cases lower) than the temperature of the water in the well or spring at the point of discharge. The temperatures listed in table 6 are those obtained only from water issuing directly from a spring or well.

SUMMARY

The occurrence, quantity, and quality of ground water available in Greene County are controlled largely by the character of the geologic formations of the area. These consist of consolidated rocks, which underlie the entire area, and unconsolidated deposits, which nearly everywhere mantle the consolidated rocks but are thickest in the valley and lowland areas.

Both the geologic structure and the lithology of these rocks and deposits in large part control the amount of ground water present below the surface and the manner and rate of its movement to wells or springs.

Of the nine principal water-bearing units mapped in Greene County, seven are consolidated rocks falling into three general groups: a belt of predominantly shaly rocks on the east, a belt predominantly of limestones in the middle, and a belt of shales and sandstones on the west. The oldest and most deformed of these seven units are the Deepkill shale of Early Ordovician age and the Normanskill shale of Middle Ordovician age, which together form the eastern belt. Ground water in this belt is hard and high in dissolved solids and iron. Furthermore, water is available in only small quantities, the yields of 70 wells averaging 8 gpm. Three water-bearing units, principally limestones, are included in the series of formations extending from the Rondout to the Onondaga limestones, inclusive, ranging in age from Late Silurian to Middle Devonian. These underlie a narrow north-south belt one to two miles wide, parallel to the Hudson Valley. As the limestones are soluble, water obtained from them has a high mineral content and a high hardness. Drainage may pass underground through sinkholes in the limestone formations, and springs associated with this drainage are common. The yields of wells average about 10 gpm but vary markedly from well to well and depend on the chance penetration of enlarged water-bearing joints. Three water-bearing units, the Mount Marion, Ashokan, and Catskill formations of Middle to Late Devonian age, underlie nearly 90 percent of Greene County and form the western belt. They consist of sandstones interbedded with shales, little distorted. Water in these units is commonly soft and low in dissolved solids, but may be high in iron. The Mount Marion and Ashokan formations are poor water producers, yielding to wells an average of 3 and 8 gpm, respectively. The Catskill formation, which underlies the Catskill Mountains and a considerable area east of the Mountains in the Townships of Cairo, Durham, and Greenville, has the largest yields of all the bedrock units, averaging 17 gpm for 198 wells. Most of the water is derived from sandstone.

As Recent alluvium is not an important water-bearing material in Greene County because of the small size of the deposits, the principal unconsolidated water-bearing material consists of Pleistocene drift. The Pleistocene drift is divided into unstratified and stratified deposits. The unstratified deposits consist primarily of till and occur as ground moraine over most of the County. The water in the till ranges widely in quality and may be hard, high in iron, or both. Although Pleistocene till is widespread and yields sufficient water for small domestic use to dug wells, it does not yield water to drilled or driven wells. The stratified deposits include fine-grained units, such as lacustrine clays in parts of the Hudson River valley, the Catskill Creek valley, the Schoharie River valley, and other lesser areas, that yield no water but act as confining beds retaining water under artesian pressure in underlying or interbedded sand and gravel. Coarse-grained stratified deposits, such as sand and gravel occurring along stream valleys, ordinarily are highly permeable and may yield large quantities of water to properly developed wells. In water from Pleistocene sand and gravel most mineral constituents are in small enough quantities that the water is satisfactory for general use.

Thus, in Greene County, the largest supplies of ground water and waters of the best chemical quality are obtained from the Pleistocene sand and gravel and from sandstone of the Catskill formation. Adequate supplies of ground water for domestic and farm use may be obtained almost anywhere in the County from drilled wells in bedrock, with the exception of occasional dry wells in the Mount Marion formation and in the Normanskill shale. There are no known areas in Greene County where the supply of ground water is being critically depleted. On the contrary, the overall supply is sufficient to meet present demands and is capable of supporting still larger pumpage in the future.

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Table 5.—Logs of selected wells in Greene County, N. Y.
(Altitudes are interpolated from topographic map.)

G 6; 11V, 11.9S, 4.0E; drilled by R. Stoutenburg in 1942; altitude 1,530 feet.

	Thickness (feet)	Depth (feet)
Bedrock, red	30	120
Sandstone, gray	30	150
Sandstone, red	50	200
Shale, red	38	238

G 11; 11V, 13.0S, 5.0E; drilled by A. Richardson in 1941; altitude 1,232 feet.

Gravel, red	30	30
Clay	90	120
Gravel and sand	13	133

G 30; 11V, 16.4S, 4.8E; drilled by Leon Van Loan in 1937; altitude 1,240 feet.

Gravel	70	70
Quicksand	70	140
Clay, blue	40	180
Gravel, large	4	184

G 31; 12V, 0.6S, 6.8E; drilled by J. Stoutenburg in 1943; altitude 1,320 feet.

Gravel	25	25
Clay, red	75	100
Hardpan	30	130
Sandstone, gray-green	115	245

G 36; 12V, 4.2S, 10.4E; drilled by R. W. Stoutenburg in 1944; altitude 1,890 feet.

Soil	6	6
Clay, red	84	90
Quicksand	10	100
Sand, coarse	2	102

G 40; 12V, 3.1S, 6.0E; drilled by C. Richardson in 1925; altitude 1,560 feet.

Soil, reddish-black	10	10
Clog-a-mire	50	60
Sand and gravel	30	90

G 42; 12V, 1.2S, 5.5E; drilled by Briggs & Richardson in 1930; altitude 1,540 feet.

	Thickness (feet)	Depth (feet)
Soil	3	3
Clay	37	40
Sand	63	103

Table 5.—Logs of selected wells in Greene County, N. Y.—Continued
(Altitudes are interpolated from topographic map.)

		Thickness (feet)	Depth (feet)
G 72;	12W, 3.8S, 3.7E; drilled by R. Stoutenburg in 1942; altitude 1,720 feet.		
	Clay, red and hardpan	78	78
	Sandstone, blue	42	120
	Sandstone, red	30	150
	Sandstone, blue	31	181
G 79;	12W, 8.1S, 8.4E; drilled by H. Lapo in 1942; altitude 2,160 feet.		
	Hardpan and boulders	15	15
	Bluestone	20	35
	Shale, red	40	75
	Bluestone	35	110
G 85;	12W, 3.5S, 8.0E; drilled by Hasbrouck Bros. in 1932; altitude 2,000 feet.		
	Hardpan and boulders	44	44
	Slate, red	21	65
	Bluestone	30	95
	Shale, red	23	118
	Sandstone, blue	8	126
G 111;	12W, 2.0S, 0.1E; drilled by Richardson Bros. in 1945; altitude 1,600 feet.		
	Soil	80	80
	Gravel	10	90
	Bluestone	5	95
	Shale, red	35	130
	Slate, black	10	140
G 126;	12W, 0.9N, 2.3E; drilled by R. Stoutenburg in 1940; altitude 2,060 feet.		
	Hardpan	40	40
	Bluestone, medium-hard	60	100
	Sandstone, red	50	150
	Bluestone	30	180
	Slate, red	17	197
G 140;	12V, 1.7N, 9.4E; drilled by C. Richardson in 1939 (approx.); altitude 2,000 feet.		
	Hardpan and boulders	15	15
	Rock, soft, red	75	90
	Bluestone, hard	20	110
	Rock, hard, red	70	180
	Slate, soft, green	12	192
	Rock, soft, dark-red	20	212
	Rock, hard, gray	28	240

Table 5.—Logs of selected wells in Greene County, N. Y.—Continued
(Altitudes are interpolated from topographic map.)

	Thickness (feet)	Depth (feet)
G 143; 12V, 1.3N, 10.1E; drilled by L. Van Loan in 1940; altitude 1,780 feet.		
Soil, red	16	16
Sandstone, soft, gray	20	36
Shale, soft, red	22	58
Rock, hard, red	31	89
Sandstone, hard, gray	19	108
G 156; 12V, 5.6N, 9.7E; drilled by R. Stoutenburg in 1942; altitude 1,900 feet.		
Hardpan and clay	7	7
Shale, red	43	50
Rock, blue, medium-hard	40	90
Sandstone, gray	30	120
Shale, red	30	150
G 189; 12W, 2.1N, 3.3E; drilled by Hugh McLean in 1943; altitude 1,800 feet.		
Hardpan and boulders	20	20
Clay	12	32
Hardpan and boulders	24	56
Shale, red	13	69
Shale, gray	3	72
Bluestone	4	76
Shale, gray	4	80
Shale, red	6	86
Bluestone	6	92
Shale, red	7	99
Bluestone	11	110
Shale, red	35	145
G 215; 12W, 8.8N, 8.8E; drilled by Richardson Bros. in 1940; altitude 500 feet.		
Soil and boulders	27	27
Shale, red	123	150
Rock, black	8	158
G 243; 12W, 9.0N, 3.8E; drilled by J. South in 1943; altitude 1,600 feet.		
Soil	2	2
Clay	4	6
Shale, soft, red	16	22
Rock, gray	63	85
Rock, black	2	87

Table 5.—Logs of selected wells in Greene County, N. Y.—Continued
(Altitudes are interpolated from topographic map.)

	Thickness (feet)	Depth (feet)
G 251; 12X, 2.4N, 1.6E; drilled by R. Stoutenburg in 1943; altitude 250 feet.		
Hardpan dirt	20	20
Bluestone	60	80
Sandstone, gray	40	120
Slate, red	40	160
Bluestone	40	200
Slate, red	25	225
G 256; 12W, 4.2N, 10.1E; drilled by R. Stoutenburg in 1944; altitude 700 feet.		
Hardpan	34	34
Bluestone	46	80
Slate, red, very porous	67	147
G 282; 12W, 1.3N, 11.9E; drilled by O. Hendricks, altitude 680 feet.		
Rock, loose	6	6
Rock, hard, white	51	57
G 295; 12X, 3.0N, 2.0E; drilled by A. Richardson in 1931; altitude 260 feet.		
Soil	9	9
Sand and gravel	30	39
Hardpan	11	50
Rock, black	22	72
G 297; 12X, 5.3N, 1.7E; drilled by A. Richardson; altitude 720 feet.		
Soil	2	2
Hardpan	9	11
Rock, blackish-gray	19	30
Rock, black and green	15	45
Rock, blue	15	60
G 303; 12X, 4.6N, 3.4E; drilled by W. Tallman in 1942; altitude 610 feet.		
Soil	12	12
Gravel, red	9	21
Rock, gray	25	46
Rock, red	19	65
G 321; 12W, 9.0N, 11.2E; drilled by A. Richardson in 1935; altitude 800 feet.		
Soil	2	2
Clay and hardpan, blue	68	70
Rock, red	10	80
Rock, gray	10	90
Rock, blue	10	100
Rock, hard, blue	20	120
Rock, red	10	130
Shale, red	10	140

Table 5.—Logs of selected wells in Greene County, N. Y.—Continued
(Altitudes are interpolated from topographic map.)

		Thickness (feet)	Depth (feet)
G 334;	12W, 8.3N, 12.6E; drilled by W. Tallman in 1941; altitude 840 feet.		
	Shale, dark-red	17	17
	Sandstone, hard	13	30
	Shale, gray	50	80
	Shale, red	30	110
	Rock, soft, gray	80	190
	Soapstone, soft	60	250
	Rock, soft, gray	100	350
	Rock, hard, gray	130	480
G 350;	12W, 7.6N, 10.6E; drilled by C. Richardson in 1944; altitude 460 feet.		
	Hardpan and soil, sandy	0	32
	Slate, soft, red	8	40
	Rock, blue-gray	12	52
	Slate, soft, red	20	72
	Rock, green	6	78
	Rock, red and green	42	120
G 401;	12X, 11.7N, 3.8E; drilled by Briggs & Richardson in 1930; altitude 800 feet.		
	Soil	4	4
	Shale, brown	10	14
	Bluestone, hard	80	94
G 410;	12X, 12.1N, 8.8E; drilled by C. Richardson in 1935; altitude 380 feet.		
	Soil and clay, yellow	6	6
	Limestone	74	80
G 417;	12X, 5.7N, 7.7E; drilled by H. McLean in 1942; altitude 124 feet.		
	Clay, blue	100	100
	Quicksand	40	140
	Slate, gray	10	150
G 418;	12X, 6.8N, 8.0E; drilled by Richardson Bros. in 1941; altitude 110 feet.		
	Clay, blue	140	140
	Hardpan and gravel	20	160
G 420;	12X, 5.4N, 8.7E; drilled by John South in 1945; altitude 180 feet.		
	Clay and boulders	16	16
	Lime, hard and flint rock with occasional layers of soft gray rock 4 to 5 feet thick	317	333

Table 5.—Logs of selected wells in Greene County, N. Y.—Continued
(Altitudes are interpolated from topographic map.)

G 428; 12X, 6.8N, 7.0E; drilled by A. Richardson Bros. in 1940; altitude 322 feet.

	Thickness (feet)	Depth (feet)
Soil	8	8
Slate, black	50	58
Bluerock, hard and soft	170	228

G 439; 12X, 7.7N, 7.0E; drilled by Richardson Bros. in 1947; altitude 385 feet.

Hardpan and stone, fine	102	102
Lime and flint rock	68	170

G 442; 12X, 8.7N, 3.5E; drilled by J. South in 1945; altitude 520 feet.

Sand and gravel	16	16
Bedrock, very hard, milkwhite	44	60

G 444; 12X, 7.8N, 9.4E; drilled by H. Lapo in 1938; altitude 140 feet.

Shale, black	350	350
Limestone	250	600

G 445; 12X, 7.0N, 6.8E; drilled by A. Richardson & Son in 1940; altitude 300 feet.

Soil	20	20
Shale, black	30	50
Limestone	41	91

G 448; 12X, 6.0N, 7.8E; drilled by Hall & Co. in 1932; altitude 130 feet.

Clay, yellow	20	20
Clay, blue	94	114
Gravel	9	123

G 451; 12X, 6.6N, 7.9E; drilled by A. Richardson & Son in 1941; altitude 120 feet.

Soil	2	2
Clay, blue	157	159
Gravel	1	160

G 471; 12X, 0.6S, 8.1E; drilled by Amos Post in 1906; altitude 165 feet.

	Thickness (feet)	Depth (feet)
Soil	2	2
Clay, yellow	58	60
Hardpan	100	160
Bedrock	5	165

G 494; 12X, 2.6N, 9.3E; drilled by John South in 1945; altitude 160 feet.

Old dug well	16	16
Gravel, fine	8	24
Limestone with very hard streaks	41	65

Table 5.—Logs of selected wells in Greene County, N. Y.—Continued

(Altitudes are interpolated from topographic map.)

G 539; 12W, 4.9S, 12.5E; drilled by Hugh McLean in 1945; altitude 480 feet.		
Hardpan and boulders	42	42
Shale, red	12	54
Bluestone	16	70
Shale, red	7	77
G 547; 12X, 1.4S, 6.7E; drilled by Germantown Artesian Well Co. in 1938; altitude 160 feet.		
Soil	5	5
Slate, blue	5	10
Rock, hard, blue	25	35
Rock, soft, blue	45	80
Rock, hard, blue	50	130
G 552; 12X, 0.4S, 4.7E; drilled by Bernard Lapo in 1944; altitude 160 feet.		
Soil	2	2
Sand	13	15
Clay, blue	129	144
Limestone, flint-bearing	31	175
G 605; 12X, 3.5S, 3.9E; drilled by Germantown Artesian Well Co. in 1940; altitude 280 feet.		
Hardpan	5	5
Limestone, hard	49	54
Shale, black	23	77

Table 6.—Records of selected wells in Greene County, New York

Location: For explanation of location symbols see, "Methods of investigation."
Altitude above sea level: Approximate altitude from topographic map.
Type of well: Drl, drilled; Drv, driven.

Water level below land surface: Reported average water level.
Use: Com, commercial; Dom, domestic; Ind, industrial; Obs, observation; PWS, public water supply.

Well number	Location	Owner	Altitude above sea level (feet)	Type of well	Depth (feet)	Diameter (inches)	Depth to bedrock (feet)	Geologic subdivision	Water level below land surface (feet)	Method of lift	Yield (gallons per minute)	Use	Remarks
G 1	12X, 9.7N, 10.1E	Esther Andersen	125	Dug	18.6	36	18.6	Pleistocene gravel	2.59	Suction	..	Obs.	Used as U. S. Geological Survey observation well.
G 2	12V, 3.1N, 7.5E	M. Ferris	1380	Drv	10.8	2	10.8	do.	5.56	do.	..	Farm	Used only in dry seasons for 35 head of stock.
G 3	12V, 2.7N, 4.8E	Clarence Brandon	1340	Drl	54	6	22	Catskill formation	5	do.	35	Farm	(a).
G 4	12V, 3.2N, 4.3E	Ralph Murray	1210	Drl	11	36	..	Pleistocene till	7	..	..	Dom	(a).
G 6	12V, 5.4N, 4.0E	R. Cammer	1530	Drl	62	6	40	Catskill formation	100	Force	10	Farm	Reported drawdown 110 feet when pumped at rate of 10 gpm for 12 hours. Temperature 49°F., October, 1945. [b]
G 7	12V, 5.7N, 4.3E	J. B. Fredenburgh	1620	Drl	230	6	..	Pleistocene gravel	30	..	40	Farm	Pumped at rate of 40 gpm for 3 hours.
G 11	12V, 4.2N, 5.0E	Walter Micha	1230	Drl	133	6	133	do.	..	Suction	4	Com	Well is used for several cabins. [b]
G 12	12V, 4.2N, 5.1E	V. Every	1240	Drl	150	6	..	do.	..	do.	4	Dom	Water reported to contain hydrogen sulfide.
G 13	12V, 4.1N, 5.4E	C. G. Conine	1240	Drl	102	5	..	do.	..	None	75	Farm	Well flows.
G 15	12V, 4.4S, 0.7E	Dan Franklin Dairies, Inc.	1760	Drl	29	6	..	do.	7	Suction	150	Ind	Temperature 52°F., October, 1945.
G 16	12V, 4.3S, 0.7E	Dan Franklin Dairies, Inc.	1760	Drl	188	6	90	Catskill formation	..	None	..	Ind	Not used; water reported to contain hydrogen sulfide.
G 18	12V, 3.8S, 1.3E	A. N. Miller	1790	Drl	50	6	..	Pleistocene gravel	15	..	6	Dom	
G 19	12V, 3.7S, 1.2E	J. E. Peet	1790	Drl	60	6	58	Catskill formation	15	..	10	Dom	Drawdown 35 feet when pumped for four hours at rate of 950 gpm.
G 20	12V, 3.6S, 1.3E	C. Kelly	1800	Drv	16	1¼	..	Pleistocene gravel	..	Suction	2	Dom	(a).
G 21	12V, 3.4S, 1.2E	J. Stevens	1870	Drl	95	6	..	do.	30	..	10	Dom	
G 23	12V, 1.8S, 1.4E	P. Politzer	1900	Drl	128	6	3	Catskill formation	108	Force	3	Dom	
G 27	12V, 0.6S, 8.3E	R. A. Wiesner	1340	Dug	22	36	..	Pleistocene gravel	3	Suction	..	Dom	
G 28	12V, 0.7S, 7.1E	Otto Deyo	1330	Drl	117	6	..	Pleistocene gravel	42	Jet	25	Dom	Temperature 48°F., September, 1945.
G 30	12V, 0.9N, 4.8E	Robert Dymond	1240	Drl	184	6	..	do.	20	Suction	250	Ind	Well flowed when drilled. [b]
G 31	12V, 0.6S, 6.8E	Lexington Farms, Inc.	1320	Drl	245	6	130	Catskill formation	50	Force	150	Ind	Average pumpage 216,000 gallons per day. [b]
G 32	12V, 0.6S, 6.7E	Lexington Farms, Inc.	1320	Drl	202	6	100	do.	50	do.	140	Ind	Average pumpage 202,000 gallons per day.
G 33	12V, 1.3S, 5.7E	R. H. Kirk	1380	Drl	109	6	..	Pleistocene gravel	90	do.	20	Farm	
G 35	12V, 4.1S, 9.8E	E. Pritzlaff	1880	Drl	128	6	..	do.	20	Jet	20	Com	No drawdown reported after pumping one hour at 20 gpm.
G 36	12V, 4.2S, 10.4E	C. Van Volkerburg	1890	Drl	102	6	..	Pleistocene sand	29	do.	40	Farm	Temperature 48°F., September, 1945. [b]
G 37	12V, 3.2S, 6.4E	Charles Graff	1560	Drl	160	6	127	Catskill formation	..	do.	5	Dom	(a).
G 40	12V, 3.1S, 6.0E	William Deyoe	1560	Drl	90	6	..	Pleistocene gravel	7	..	15	Dom	(b).

See footnotes at end of table.

Table 6.—records of selected wells in Greene County, New York (Continued)

Well number	Location	Owner	Altitude above sea level (feet)	Type of well	Depth (feet)	Diameter (inches)	Depth to bedrock (feet)	Geologic subdivision	Water level below land surface (feet)	Method of lift	Yield (gallons per minute)	Use	Remarks
G 42	12V, 1.2S, 5.5E	Walter Turk	1540	Drl	102	6	..	Pleistocene sand	40	Force	20	Farm	No drawdown reported when pumped at rate of 20 gpm for 4 hours. [b]
G 43	12V, 0.3S, 6.6E	L. LaMent White	1340	Drl	23	1½	..	do.	..	Suction	..	Dom	(a).
G 45	12V, 1.2N, 4.8E	Priscilla Goff	1230	Drl	60	6	..	Pleistocene sand	15	..	6	Farm	Some water reported at 25 feet.
G 46	12V, 3.1S, 5.5E	A. B. Flick	1460	Drl	120	6	80	Catskill formation	..	Force	9	Dom	
G 47	12V, 0.7S, 6.9E	E. B. Ostrander	1380	Drl	125	6	..	Pleistocene gravel	50	Jet	5	Dom	Drawdown reported to be 15 feet after pumping for 3 hours.
G 49	12V, 0.4N, 8.4E	David Miller	1840	Drl	40	6	10	Catskill formation	6	Force	4	Farm	
G 53	12W, 3.8S, 7.1E	Giovanni Manco	1940	Drl	131	6	5	do.	35	do.	15	Com	Well serves 50 people.
G 55	12W, 4.1S, 4.6E	F. Vaughan	1880	Drl	130	6	110	do.	90	do.	30	Farm	
G 56	12W, 4.1S, 3.4E	Harry L'Hommedieu	1700	Drl	79	6	..	Pleistocene gravel	20	..	..	Dom	
G 57	12W, 8.1S, 8.6E	Charles Schofield	2250	Dug	17	36	..	Pleistocene till	14	..	..	Dom	(a).
G 59	12W, 7.8S, 9.0E	Johnas Clum	1[illegible]60	Dug	11	30	..	do.	3.01	Pitcher	..	Dom	
G 69	12W, 1.9S, 6.1E	Harold Latham	2360	Drl	116	6	43	Catskill formation	16	..	27	Dom	Reportedly pumped at rate of 27 gpm for 24 hours.
G 72	12W, 3.8S, 3.7E	Jack Rogrosky	1720	Drl	1[illegible]1	6	78	do.	..	Jet	20	Dom	(b).
G 75	12W, 4.0S, 6.8E	H. Byrne	19[illegible]0	Drl	142	6	97	do.	32	Force	10	Dom	Water reported at contact of red shale and sandstone.
G 77	12W, 7.0S, 6.9E	William Dale	1900	Dug	10	36	..	Pleistocene deposits	.5	Suction	..	Dom	
G 79	12W, 8.1S, 8.4E	Mary Riley Estate	2160	Drl	110	6	15	Catskill formation	30	None	8	None	Well not used. [b]
G 80	12W, 4.9S, 4.5E	J. Kissley	1960	Drl	118	6	..	Catskill formation	..	..	5	Com	(a).
G 81	12W, 3.8S, 7.7E	Mildred Hill	1980	Drl	195	6	69	do.	42	Jet	25	Dom	
G 85	12W, 3.5S, 8.0E	William Whittaker	2000	Drl	126	6	44	do.	..	Suction	..	Dom	Well flows. [a] [b]
G 86	12W, 3.9S, 9.6E	P. Schutt	2000	Drl	115	6	89	do.	..	do.	3	Dom	Well flows about 2½ gpm.
G 89	12W, 3.8S, 7.5E	T. B. Lowerre	2100	Drl	412	6	100	do.	80	Force	10	Dom	
G 91	12W, 3.5S, 9.0E	P. J. Feeley	2200	Drl	49	6	50	do.	..	do.	2	Dom	
G 94	12W, 3.1S, 7.3E	G. Knapp	2150	Drl	107	10	50	do.	..	do.	..	Dom	
G 98	12W, 4.2S, 8.1E	W. T. Gornell	2600	Drl	210	6	14	do.	..	..	10	Dom	Some water reported near top of bedrock.
G 101	12W, 3.4S, 3.3E	H. Greenblatt	1[illegible]00	Drl	202	6	62	do.	97	Force	4	Com	Drawdown reported to be 20 feet when pumped at 4 gpm.
G 103	12W, 5.5S, 2.6E	Frances Bus	2000	Drl	53	6	..	Pleistocene gravel	21	Suction	30	Dom	
G 104	12W, 2.1S, 6.6E	Toppersfield Manor	2360	Drl	230	6	7	Catskill formation	80	Force	8	Com	Yield 3½ gpm at 120 feet, 7½ gpm at 220 feet.
G 106	12W, 1.3S, 5.8E	G. T. Benjamin	2100	Drl	78	6	14	do.	15	..	10	Dom	Yield 6 gpm at 24 feet, 10 gpm at 75 feet.
G 111	12W, 2.0S, 0.1E	Otto Laga	1600	Drl	140	6	90	do.	..	..	5	Dom	Water reported to contain hydrogen sulfide. Temperature 42°F., Sept., 1945. [b]

See footnotes at end of table.

Table 6.—records of selected wells in Greene County, New York (Continued)

Well number	Location	Owner	Altitude above sea level (feet)	Type of well	Depth (feet)	Diameter (inches)	Depth to bedrock (feet)	Geologic subdivision	Water level below land surface (feet)	Method of lift	Yield (gallons per minute)	Use	Remarks
G 113	12W, 0.9S, 0.1E	John Sturtecky	1890	Drl	54	6	4	Catskill formation	20	..	10	Dom	
G 116	12V, 0.9S, 10.1E	F. H. Goslee	1600	Drl	119	6	8	do.	1	Jet	20	Dom	Yield 2 gpm at 50 feet.
G 119	12V, 1.6N, 11.0E	Viola Shaw	2000	Drl	386	6	162	do.	87	Force	6	Com	Yield 2½ gpm at 240 feet.
G 125	12W, 0.5N, 2.5E	M. Beers	1960	Drl	152	6	19	do.	15	..	9	Farm	Yield 1 gpm at 130 feet. Temperature 38°F., October, 1945.
G 126	12W, 0.9N, 2.3E	Ward Van Loan	2060	Drl	197	6	40	do.	100	Force	15	Com	Pumped at 15 gpm for 24 hours. [b]
G 127	12W, 1.0N, 2.1E	Harry Van Loan	2060	Drl	265	6	25	do.	50	do.	10	Com	Main water bed at 260 feet.
G 131	12W, 1.0N, 3.6E	A. V. Biegen	1860	Drl	80	6	2	do.	20	do.	..	Dom	Water used for summer camp.
G 132	12V, 1.4N, 10.2E	N. E. Morse	1800	Drl	80	6	2	do.	50	do.	20	Dom	No drawdown reported after pumping at rate of 20 gpm for ½ hour. [a]
G 135	12W, 1.2S, 5.4E	Anson Kirk	2000	Drl	165	6	107	do.	60	do.	7	Dom	Drawdown reported to be 45 feet when pumped at rate of 7 gpm.
G 137	12W, 1.7S, 6.2E	P. Fromer	2510	Drl	600	6	6	do.	285	None	1	None	Well not used.
G 140	12V, 1.7N, 9.4E	Ralph Rirkman	2000	Drl	240	6	15	do.	80	Force	15	Dom	Yield 4 gpm at 85 feet. [b]
G 141	12V, 1.0N, 8.9E	John Mattera	1880	Drl	101	5	60	do.	25	..	11	Farm	(a).
G 142	12V, 0.8N, 9.3E	E. Higgins	1980	Drl	80	6	55	do.	2	..	6	Dom	
G 143	12V, 1.3N, 10.1E	J. Amberino	1780	Drl	108	6	16	do.	6	Jet	36	Dom	Yield 30 gpm at 6 feet. [b]
G 145	12V, 1.5S, 11.9E	Marie's Coffee Shop	1540	Dug	7	60	..	Pleistocene till	4	None	..	None	
G 146	12W, 5.5N, 2.1W	Harold Conine	1700	Drl	170	6	100	Catskill formation	30	Jet	35	Farm	Water reported to contain hydrogen sulfide.
G 147	12V, 5.5N, 9.4E	A. Gooss	2000	Drl	120	6	28	do.	65	do.	5	Com	Some water reported at 75 feet. [a]
G 148	12V, 3.8N, 10.9E	Frank Holdridge	1540	Drl	156	6	10	do.	30	Force	10	Com	Supplies 30 people.
G 150	12V, 3.8N, 8.5E	A. V. Clark	1420	Drl	136	6	45	do.	..	Suction	5	Dom	Yield 1½ gpm at 64 feet.
G 152	12V, 3.5N, 8.1E	Bruce Tompkins	1420	Drl	164	6	..	Pleistocene gravel	27	Force	5	Farm	Temperature 47°F., October, 1945. [a]
G 153	12V, 5.6N, 6.8E	Joseph Porter	2000	Drl	115	6	19	Catskill formation	40	do.	8	Dom	
G 154	12V, 4.1N, 6.0E	L. S. Fabri	1400	Drl	138	6	38	..	25	..	30	Dom	Water reported to contain hydrogen sulfide.
G 155	12V, 5.3N, 9.1E	Carl Weibel	1900	Drl	200	6	7	Catskill formation	40	Force	3	Dom	
G 156	12V, 5.6N, 9.7E	E. Case	1900	Drl	150	6	7	do.	60	do.	3	Dom	(b).
G 158	12V, 5.1N, 7.3E	A. Pease	1880	Drl	80	6	40	do.	40	do.	3	Dom	
G 159	12V, 3.8N, 6.5E	A. Rehanek	1340	Drl	80	6	..	do.	..	do.	4	Dom	
G 162	12W, 2.2N, 1.4E	P. Polati	1840	Drl	192	6	28	do.	100	do.	20	Dom	Yield 1½ gpm at 75 feet and 3 gpm at 125 feet.
G 163	12W, 2.5N, 1.8E	D. Dormans Inn	1620	Drl	104	6	60	do.	4	None	10	None	Yield 5 gpm at 75 feet.
G 166	12W, 3.7N, 2.4E	E. C. Andrus	1680	Drl	126	6	55	do.	35	Force	43	Dom	
G 167	12W, 3.8N, 1.9E	Herbert Jones	1680	Drl	80	6	17	do.	25	Jet	3	Dom	

See footnotes at end of table.

Table 6.—records of selected wells in Greene County, New York (Continued)

Well number	Location	Owner	Altitude above sea level (feet)	Type of well	Depth (feet)	Diameter (inches)	Depth of bedrock (feet)	Geologic subdivision	Water level below land surface (feet)	Method of lift	Yield (gallons per minute)	Use	Remarks
G 169	12W, 4.4N, 1.7E	W. J. Detmar	1760	Drl	201	6	50	Catskill formation	10	Pitcher	3	Dom	
G 171	12W, 4.6N, 0.2E	Joseph Turpish	1780	Drl	38	6	24	do.	6	Suction	8	Dom	
G 172	12W, 5.4N, 0.2E	S. Bernhard	1660	Drl	108	6	16	do.	..	do.	30	Dom	
G 175	12W, 4.2N, 0.6E	W. J. Soper	1600	Drl	135	6	25	do.	..	Force	6	Com	Another similar well 70 feet away.
G 176	12W, 4.0N, 0.9E	W. J. Soper Estate	1540	Drl	100	6	40	do.	..	Suction	35	Com	Well flowed at rate of about 3 gpm.
G 178	12V, 3.8N, 11.7E	George Muller	1500	Drl	98	6	30	do.	35	Force	15	Ind	Some water reported at 35 feet.
G 179	12V, 5.8N, 7.0E	F. LeBrun	1900	Drl	115	6	100	do.	15	Jet	..	Dom	
G 181	12W, 1.7N, 3.1E	V. W. Morrow	1760	Drl	140	6	11	do.	..	Suction	..	Com	Well flows. [a]
G 185	12W, 2.5N, 4.2E	Syrus Hoyt	1900	Drl	155	6	33	do.	30	Force	6	Dom	
G 186	12W, 2.9N, 6.3E	N. West	2080	Drl	82	6	53	do.	19	None	8	None	Temperature 50°F., October, 1945.
G 187	12W, 1.8N, 3.0E	John Planck	1760	Drl	83	6	20	do.	..	do.	25	Dom	Yield 10 gpm at 35 feet.
G 188	12W, 2.2N, 2.5E	J. F. Twohy	1700	Drl	109	6	40	do.	30	Jet	8	Dom	
G 189	12W, 2.1N, 3.3E	Moseman and Martin	1800	Drl	140	8	59	do.	..	Force	24	Com	Well flowed when drilled. [b]
G 190	12W, 2.0N, 3.5E	Moseman and Martin	1800	Drl	120	6	..	do.	2	do.	40	Com	Water rose 2½ feet above surface when drilled.
G 191	12W, 1.8N, 3.4E	Moseman and Martin	1800	Drl	121	6	26	do.	3	Jet	30	Com	Drawdown reported to be 67 feet after pumping 3 hours.
G 192	12W, 1.8N, 3.3E	Moseman and Martin	1800	Drl	130	6	20	do.	..	..	10	Com	Water reported to contain hydrogen sulfide.
G 194	12W, 4.1N, 1.1E	G. H. Chamberlain	1680	Drl	143	6	32	do.	..	Suction	35	Com	Yield 3 gpm at 73 feet. [a]
G 196	12W, 1.8N, 3.1E	Roger Richards	1700	Drl	80	6	22	..	..	..	..	Dom	Yield 2½ gpm at 20 feet and 5 gpm at 70 feet.
G 198	12V, 3.9N, 12.4E	Central School Dist. 1	1500	Drl	35	10	35	Pleistocene sand	..	..	30	Dom	
G 205	12W, 6.0N, 4.7E	T. Fiorentini	2000	Drl	323	8	3	Catskill formation	200	Force	15	Com	Supplies up to 100 people.
G 207	12W, 8.5N, 8.2E	Grace Meloy	540	Drl	125	6	25	do.	34	do.	15	Dom	Drilled in bottom of old well 25 feet deep. [a]
G 209	12W, 8.6N, 8.2E	Meloy and Roe	560	Drl	220	6	200	do.	18	Jet	14	Dom	
G 210	12W, 8.3N, 8.7E	John McIntyre	500	Drl	130	6	..	Pleistocene gravel	..	..	15	Com	Well flows.
G 211	12W, 8.0N, 8.6E	John McIntyre	500	Drl	200	6	110	Catskill formation	6	Suction	12	Com	Three wells and a spring on this property.
G 214	12W, 0.7N, 9.2E	Helen Peters	540	Drl	81	6	65	do.	..	..	12	Com	Principal water bed reported at 78 feet.
G 215	12W, 8.8N, 8.8E	P. Lawton	500	Drl	168	6	30	do.	5	Jet	7	Com	Well reported to contain some gas. [b]
G 216	12W, 8.9N, 8.6E	P. Lawton	500	Drl	75	6	30	do.	15	Suction	50	Dom	do.
G 219	12W, 9.1N, 7.0E	E. J. Searing	600	Dug	21	6	..	Pleistocene deposits	8	do.	..	Dom	Temperature 45°F., November, 1945.
G 221	12W, 9.7N, 6.1E	H. Karkheck	680	Drl	102	6	80	Catskill formation	60	None	2	None	Well abandoned.
G 225	12W, 10.2N, 2.2E	John Rameo	1340	Drl	114	6	7	do.	50	Force	5	Dom	Main water bed reported at 59 feet.

See footnotes at end of table.

Table 6.—records of selected wells in Greene County, New York (Continued)

Well number	Location	Owner	Altitude above sea level (feet)	Type of well	Depth (feet)	Diameter (inches)	Depth to bedrock (feet)	Geologic subdivision	Water level below land surface (feet)	Method of lift	Yield (gallons per minute)	Use	Remarks
G 227	12W, 10.5N, 4.3E	R. Hull	640	Drl	81	6	8	Catskill formation	10	Jet	9	Dom	
G 228	12W, 10.9N, 4.8E	H. E. Poultney	660	Drl	74	6	..	Pleistocene deposits	..	..	8	Farm	Well flows.
G 231	12W, 10.6N, 7.4E	P. Geres	720	Drl	160	6	73	Catskill formation	18	Force	4	Com	
G 232	12W, 10.1N, 7.8E	G. Schneider	620	Drl	210	6	48	do.	60	do.	5	Farm	Supplies 2 houses and 23 head of stock. [a]
G 233	12W, 10.5N, 7.8E	J. J. Rundell	860	Dug	19	36	..	Pleistocene till	6	Suction	..	Dom	
G 234	12W, 6.0N, 8.3E	Frank Pierson	720	Drl	281	6	30	Catskill formation	30	Force	14	Dom	
G 236	12W, 7.8N, 7.0E	B. Seidel	840	Drl	130	6	45	do.	52	do.	5	Dom	
G 237	12W, 8.1N, 5.0E	William Borthwick, Jr.	950	Drl	75	6	45	do.	..	Suction	7	Farm	Well flows.
G 241	12W, 8.1N, 3.1E	O. C. Sutton	1360	Drl	38	6	..	Pleistocene gravel	..	do.	9	Farm	do.
G 242	12W, 8.3N, 2.8E	Alex Parks	1440	Drl	110	6	6	Catskill formation	72	Force	40	Farm	No drawdown reported when pumped at 40 gpm.
G 243	12W, 9.0N, 3.8E	E. Hull	1600	Drl	87	6	22	do.	32	Jet	6	Farm	(b).
G 247	12W, 9.2N, 2.6E	Jesse Cleveland	1280	Drl	50	6	4	do.	7	..	5	Farm	Main water bed reported at 40 feet.
G 248	12W, 8.2N, 3.3E	Frank Garvasi	1300	Drl	190	6	115	do.	40	None	5	None	New well; pump not installed as of January 10, 1946.
G 249	12X, 3.7N, 0.5E	H. Wenk	400	Drl	92	6	10	do.	40	Jet	5	Com	Drawdown reported to be less than 50 ft.
G 251	12X, 2.4N, 1.6E	Reinhard Lenk	250	Drl	225	6	20	do.	28	Force	3	Com	(b).
G 254	12W, 5.2N, 10.6E	Cold Mix Corp.	480	Drl	167	6	8	do.	60	do.	40	Ind	Some water reported at 60 feet.
G 255	12W, 5.4N, 10.4E	Catskill Mt. Stone Corp.	500	Drl	290	8	3	do.	110	do.	40	Ind	Well abandoned.
G 256	12W, 4.2N, 10.1E	Archie Fortunato	700	Drl	147	8	34	do.	35	Turbine	50	Com	Supplies water for swimming pool and 87 people. [b]
G 260	12W, 2.1N, 10.4E	P. Pietschker	860	Drl	50	6	6	do.	11	..	8	Dom	Main water bed reported at bottom of well.
G 261	12W, 4.2N, 10.6E	M. Lamanec	240	Drl	130	6	1	do.	36	Force	6	Dom	Temperature 45°F., October, 1945 [a]
G 265	12W, 10.3N, 7.9E	M. Matz	900	Dug	18	12	18	Pleistocene till	8	..	..	Com	
G 266	12W, 4.6N, 8.2E	R. Lustig	980	Drl	240	6	..	Catskill formation	47.18	Force	..	..	
G 269	12W, 3.7N, 11.1E	C. Riedlbauer & J. Scholz	650	Drl	137	6	43	do.	15	Jet	20	Com	Drawdown reported to be 31 feet after pumping for 168 hours.
G 270	12W, 3.7N, 11.0E	C. Riedlbauer & J. Scholz	640	Drl	110	6	18	do.	5	Suction	18	Com	Drawdown reported to be 25 feet after pumping for 72 hours.
G 272	12W, 3.6N, 11.0E	C. Riedlbauer & J. Scholz	640	Drl	122	6	18	do.	15	Jet	15	Com	Water used for swimming pool.
G 273	12W, 3.5N, 11.4E	George Wolfer	520	Drl	229	6	25	do.	25	None	8	None	Most water reported below 130 feet.
G 276	12X, 1.9N, 2.3E	Charles Holdridge	190	Drl	88	6	20	do.	25	Force	6	Com	Water reported to contain hydrogen sulfide.
G 277	12X, 1.9N, 2.2E	George Doney	190	Drv	32	1½	..	Pleistocene sand	22	Suction	6	Dom	Drawdown less than 10 feet after pumping for 12 hours.
G 278	12X, 1.8N, 2.1E	John McTigue	280	Drl	78	6	10	Catskill formation	11	..	6	Dom	(a).

See footnotes at end of table.

Table 6.—records of selected wells in Greene County, New York (Continued)

Well number	Location	Owner	Altitude above sea level (feet)	Type of well	Depth (feet)	Diameter (inches)	Depth to bedrock (feet)	Geologic subdivision	Water level below land surface (feet)	Method of lift	Yield (gallons per minute)	Use	Remarks
G 279	12X, 1.0N, 1.5E	V. Carlson	375	Drl	75	6	25	Catskill formation	19	..	..	Dom	
G 282	12W, 1.3N, 11.9E	John South	680	Drl	57	6	6	do.	35	Force	6	Dom	
G 284	12W, 1.1N, 10.4E	Hugh McKee	860	Drl	210	6	3	do.	120	do.	2	Com	Supplies 32 guests in summer.
G 287	12W, 4.7N, 12.2E	Edmund Savage	360	Drl	50	6	10	do.	20	do.	5	Dom	Main water bed at 10 to 20 feet. [a]
G 288	12W, 5.4N, 9.4E	C. Sobrado	680	Drl	225	6	84	do.	80	do.	25	Com	Supplies 50 guests in summer.
G 290	12W, 3.6N, 12.9E	M. Feinburg	360	Drl	75	6	24	do.	20	Jet	9	Dom	Yield 4 gpm at 65 feet.
G 293	12X, 5.8N, 2.3E	Milo Vermilyea	600	Drl	55	6	30	do.	25	Force	..	Farm	Main water bed reported at contact between red rock and hard gray rock at 52 feet.
G 294	12X, 2.6N, 2.3E	R. T. Brandon	240	Drl	19	1¼	..	Pleistocene deposits	15	Suction	5	Dom	
G 295	12X, 3.0N, 2.0E	A. Esenwein	260	Drl	72	6	50	Catskill formation	30	Force	30	Dom	
G 296	12X, 4.4N, 1.7E	B. Kollar	560	Drl	528	6	12	Ashokan formation	400	None	3	None	
G 297	12X, 5.3N, 1.7E	Isaac Tischler	720	Drl	60	6	11	Catskill formation	6	None	15	Dom	
G 298	12X, 5.7N, 1.7E	Mary Ordas	760	Drl	87	6	4	do.	37	Jet	12	Dom	Main water bed reported at 63 to 80 feet.
G 299	12X, 2.1N, 3.3E	E. Cone	220	Drl	21	6	10	do.	4	Suction	35	Dom	
G 302	12X, 4.6N, 3.4E	A. Curcio	610	Drl	55	6	12	do.	6	do.	9	Com	Supplies a 56,000 gallon swimming pool.
G 303	12X, 4.6N, 3.4E	A. Curcio	610	Drl	65	6	12	do.	1	..	20	Com	Three similar wells at this location.
G 304	12X, 3.4N, 2.4E	F. Howard	300	Dug	34	36	..	Pleistocene deposits	16	Force	..	Dom	Temperature 50°F., December, 1945.
G 307	12W, 6.0N, 11.8E	William Horton	460	Drl	133	6	98	Catskill formation	69	do.	6	Dom	
G 311	12W, 1.3N, 11.5E	C. O. Alberga	640	Drl	72	6	41	do.	40	do.	12	Dom	
G 313	12W, 3.8N, 11.9E	M. Carman	480	Drl	158	6	5	do.	..	Jet	5	Dom	Originally drilled to a depth of 80 feet with a yield of 3 gpm.
G 316	12W, 11.4N, 11.7E	L. Cunningham	700	Drl	40	6	..	Pleistocene gravel	..	Suction	3	Dom	Water reported to contain hydrogen sulfide.
G 321	12W, 9.0N, 11.2E	V. Cannata	800	Drl	140	6	..	Catskill formation	7	..	15	Dom	
G 322	12W, 11.3N, 9.5E	L. H. Powell	860	Drl	66	6	11	do.	8	..	8	Dom	
G 324	12W, 10.9N, 9.9E	T. M. Elliott	840	Drl	65	6	34	do.	20	Force	65	Farm	Pumped at rate of 65 gpm for 3 hours.
G 327	12W, 9.7N, 11.1E	Oswald Gundersen	640	Dug	16	30	..	Pleistocene till	10	Suction	..	Dom	Temperature 51°F., October, 1945.
G 328	12W, 9.8N, 10.6E	A. Fursatz	600	Drl	103	6	12	Catskill formation	8	..	40	Com	Water reported to contain hydrogen sulfide.
G 330	12W, 8.6N, 9.6E	Frank Bronson	560	Drl	66	6	10	do.	2	..	30	Farm	Only one gallon per hour reported at 30 feet. [a]
G 331	12W, 8.2N, 10.1E	W. Carlson	560	Drl	179	6	14	do.	67	Force	3	Com	Pumped at 3 gpm for 48 hours.
G 332	12W, 10.8N, 9.3E	J. A. Egger	720	Drl	178	6	123	do.	9	Suction	10	Farm	
G 334	12W, 8.3N, 12.6E	A. L. Nickelsen	840	Drl	480	6	17	do.	180	Force	14	Com	Supplies 150 people and 24 head of stock. [b]
G 339	12W, 9.8N, 9.0E	R. Stern	730	Drl	93	6	65	do.	..	Jet	10	Dom	Well flows 3½ gpm. Temperature 42°F., November, 1945.

See footnotes at end of table.

Table 6.—records of selected wells in Greene County, New York (Continued)

Well number	Location	Owner	Altitude above sea level (feet)	Type of well	Depth (feet)	Diameter (inches)	Depth to bedrock (feet)	Geologic subdivision	Water level below land surface (feet)	Method of lift	Yield (gallons per minute)	Use	Remarks
G 340	12W, 9.9N, 9.0E	R. Stern	760	Drl	80	6	20	Catskill formation	4	Suction	30	Com	Supplies a 200,000 gallon swimming pool.
G 345	12X, 10.1N, 2.4E	E. Long	560	Drl	62	6	20	Ashokan formation	30	Force	4	Farm	Water reported to contain hydrogen sulfide.
G 347	12X, 10.1N, 1.4E	William Hickok	680	Drl	57	6	20	Catskill formation	28	do.	20	Dom	Yield 1½ gpm at 30 feet.
G 348	12W, 8.7N, 12.2E	B. Bear	820	Drl	204	6	131	do.	85	do.	40	Farm	Main water bed at 181 to 200 feet.
G 350	12W, 7.6N, 10.6E	A. Kuhn	460	Drl	119	6	32	do.	5	Jet	35	Dom	Supplies three families. [b]
G 351	12W, 7.4N, 11.1E	G. A. Wright	620	Drl	65	6	10	do.	15	Force	4	Dom	Well flows seasonally.
G 353	12X, 13.2N, 0.4E	C. Richardson	870	Drl	132	6	20	Ashokan formation	24	Jet	3	Dom	(a).
G 355	12X, 6.6N, 1.3E	Carl Lange	700	Drl	67	6	50	Catskill formation	10	Suction	16	Farm	
G 362	12W, 9.7N, 12.9E	C. E. Townsend	700	Drl	110	6	40	do.	20	Jet	5	Dom	
G 364	12W, 10.6N, 0.1E	J. J. Sullivan	820	Drl	80	6	14	do.	2	Force	25	Com	Supplies 60 people.
G 366	12W, 11.0N, 12.2E	L. Armstrong	740	Drl	107	6	12	do.	30	None	7	None	
G 367	12W, 10.6N, 2.3E	J. J. Roth	740	Drl	76	6	28	do.	22	do.	7	None	Some water reported at 30 feet.
G 370	12X, 3.2N, 2.2E	C. Rose	820	Drl	94	6	3	Ashokan formation	30	Jet	5	Farm	
G 372	12W, 7.4N, 10.4E	Hugo Jestand	580	Drl	55	6	28	Catskill formation	4	Pitcher	9	Dom	Main water bed at 50 to 55 feet.
G 375	12X, 10.1N, 5.9E	L. Maier	680	Drl	73	6	10	Mount Marion formation	30	Force	2	Dom	
G 376	12X, 10.9N, 3.6E	H. Turpin	610	Drl	50	6	27	Ashokan formation	15	None	2	None	
G 377	12X, 10.6N, 4.5E	Paul Schaetlich	660	Drl	80	6	20	do.	8	..	4	Farm	
G 382	12X, 12.3N, 9.5E	C. A. Albright	240	Drl	30	6	..	Pleistocene gravel	2	..	..	Com	Originally a dug well 20 feet; later deepened with post hole digger.
G 383	12X, 14.1N, 11.0E	B. B. Nelson	80	Drl	58	6	12	Normanskill shale	15	Pitcher	2	Dom	
G 385	12X, 14.1N, 11.0E	E. P. Brandow	80	Drl	76	6	12	do.	12	None	5	None	
G 388	12X, 10.5N, 10.3E	A. Spence	160	Drl	153	6	20	do.	20	Force	2	Dom	
G 393	12X, 12.7N, 10.0E	A. C. Butler	200	Drl	84	6	72	do.	1	Suction	8	Dom	Well flows seasonally. [a]
G 397	12X, 12.3N, 5.8E	C. Gross	720	Drl	355	6	7	Mount Marion formation	10	None	..	None	Well abandoned because of insufficient Water.
G 399	12X, 12.5N, 6.2E	G. Offenberger	700	Drl	480	6	26	do.	12	Suction	7	Dom	
G 401	12X, 11.7N, 3.8E	A. Rothe	800	Drl	94	6	14	Ashokan formation	26	Jet	2	Farm	Yield 1½ gpm at 56 feet. [b]
G 402	12X, 13.1N, 3.8E	Floyd Smith	840	Drl	476	6	12	Mount Marion formation	..	None	0	None	Well abandoned; two other wells, 32 and 42 feet deep, used.
G 405	12X, 9.2N, 7.5E	W. Swan	420	Drl	65	6	6	Onondaga limestone	15	Pitcher	2	Dom	
G 406	12X, 10.5N, 8.0E	A. Hotaling	400	Dug	30	30	30	Pleistocene till	26	Force	..	Dom	
G 407	12X, 10.9N, 7.8E	R. Wentworth	600	Drl	78	6	..	Pleistocene gravel	..	..	7	Dom	
G 408	12X, 11.5N, 8.4E	C. A. Lisk Estate	420	Drl	95	6	3	Onondaga limestone and Schoharie grit	38	Force	4	Farm	

See footnotes at end of table.

Table 6.—records of selected wells in Greene County, New York (Continued)

Well number	Location	Owner	Altitude above sea level (feet)	Type of well	Depth (feet)	Diameter (inches)	Depth to bedrock (feet)	Geologic subdivision	Water level below land surface (feet)	Method of lift	Yield (gallons per minute)	Use	Remarks
G 410	12X, 12.1N, 8.8E	C. C. Hallock	380	Drl	80	6	6	Helderberg group	20	Jet	4	Dom	Yield 4 gpm at 60 feet with no increase at 80 feet. [b]
G 412	12X, 9.0N, 9.8E	John Himmer	100	Drl	165	6	16	Normanskill shale	18	Force	9	Dom	
G 413	12X, 14.0N, 9.1E	T. Haney	300	Dug	24	48	..	Pleistocene gravel	18	Pitcher	..	Dom	(a).
G 415	12X, 12.7N, 7.0E	A. Harden	525	Drl	200	6	110	..	..	None	1/10	None	Well abandoned.
G 417	12X, 5.7N, 7.7E	G. W. Bergmann	125	Drl	150	6	140	Normanskill shale	..	..	20	Farm	Well reported to flow at rate of 5 gpm. [b]
G 418	12X, 6.8N, 8.0E	Leo Vermann	110	Drl	160	6	..	Pleistocene gravel	..	..	30	Dom	Well flows. [b]
G 420	12X, 5.4N, 8.7E	R. Sutton	180	Drl	333	6	16	Deepkill shale	4	..	½	None	Yield ½ gpm at 90 feet, no increase at 333 feet. [b]
G 423	12X, 4.5N, 8.8E	E. Schubert	160	Dug	10	36	..	Pleistocene till	1.30	Pitcher	..	Farm	(a).
G 424	12X, 5.4N, 9.3E	E. Swartout	240	Drl	115	6	5	Normanskill shale	10	Jet	3	Farm	Main water bed at 96 to 112 feet.
G 425	12X, 5.2N, 9.4E	A. Brower	240	Drl	127	6	6	do.	6	Suction	10	Dom	
G 427	12X, 7.0N, 8.4E	L. Reyngoudt	120	Drl	130	6	120	do.	..	..	6	Dom	Well flows.
G 428	12X, 6.8N, 7.0E	R. Wilkinson	320	Drl	228	6	8	Helderberg group	3	Suction	1	Farm	Yield 1 gpm at 22 feet, no increase at 228 feet. [b]
G 432	12X, 7.6N, 6.0E	John Moritz	400	Drl	183	6	41	Mount Marion formation	7	..	10	Dom	Well flowed when drilled.
G 437	12X, 9.1N, 6.8E	R. Bauer	560	Drl	110	6	43	do.	20	Jet	12	Dom	Yield 4 gpm at 70 feet.
G 438	12X, 7.5N, 6.8E	John Svejda	400	Drl	104	6	21	Onondaga limestone	..	..	8	Dom	Well flows seasonally.
G 439	12X, 7.7N, 7.0E	Lansing Vedder	385	Drl	170	6	103	Onondaga limestone and Schoharie grit	..	None	..	Dom	(b).
G 442	12X, 8.7N, 3.5E	K. Ciccone	520	Drl	60	6	16	Ashokan formation	30	Jet	5	Dom	(b).
G 444	12X, 7.8N, 9.4E	Knaust Bros.	140	Drl	600	6	20	Deepkill shale	25	..	10	Ind	Well flowed when drilled. [b]
G 445	12X, 7.0N, 6.8E	Knaust Bros.	300	Drl	91	6	20	Onondaga limestone	20	Force	8	Dom	(b).
G 447	12X, 4.3N, 8.7E	J. Bush	180	Drl	500	6	11	Deepkill shale	40	None	¼	None	Yield ¼ gpm at 70 to 100 feet.
G 448	12X, 6.0N, 7.8E	State Vocational Training School	130	Drl	123	10	..	Pleistocene gravel	..	do.	..	None	Well flows. [b]
G 451	12X, 6.6N, 7.9E	John Reis	120	Drl	160	6	..	do.	2	..	20	Com	Well abandoned. [b]
G 452	12X, 8.8N, 8.8E	H. Bell	120	Drl	110	6	102	Deepkill shale	16	Force	2	Com	Yield 7½ gpm at 88 feet but quicksand reduced yield to 2 gpm.
G 456	12X, 4.1N, 10.5E	C. Beck	60	Drl	354	6	125	Normanskill shale	125	do.	1	Dom	Yield 1 gpm at 125 feet, no increase at 354 feet. [a]
G 457	12X, 3.6N, 10.5E	Andrew Souchareff	120	Drl	450	6	38	Deepkill shale	26	do.	10	Com	Yield 2½ gpm at 82 feet, 10 gpm at 350 ft.
G 461	12X, 9.1N, 4.7E	R. Stuvens	580	Drl	132	6	28	Ashokan formation	10	Jet	6	Com	Two similar wells at this location.
G 463	12X, 8.3N, 9.7E	Rudolf Losert	140	Drl	180	6	..	Deepkill shale	16	Force	6	Farm	
G 470	12X, 6.2N, 7.8E	William Hass	120	Drl	265	6	165	Normanskill shale	..	Suction	20	Dom	Well flows.
G 471	12X, 0.6S, 8.1E	W. E. Thorpe, Jr.	160	Drl	189	6	187	do.	15	Force	8	Dom	Another well at this location.[b]

See footnotes at end of table.

Table 6.—records of selected wells in Greene County, New York (Continued)

Well number	Location	Owner	Altitude above sea level (feet)	Type of well	Depth (feet)	Diameter (inches)	Depth to bedrock (feet)	Geologic subdivision	Water level below land surface (feet)	Method of lift	Yield (gallons per minute)	Use	Remarks
G 475	12X, 0.6N, 8.5E	H. G. Wagner	110	Drl	400	6	10	Deepkill shale	30	Force	3	Dom	Well flows seasonally.
G 477	12X, 2.8N, 7.6E	Fred Schmidt	160	Drl	75	6	35	Normanskill shale	6	Suction	..	Dom	(a).
G 479	12X, 0.7N, 7.4E	George Deyoe	220	Drl	134	6	6	do.	..	do.	10	Com	No drawdown reported after pumping for 3½ hours at 10 gpm.
G 480	12X, 0.9N, 6.7E	George Hadden	220	Drl	100	6	8	do.	18	Jet	4	Farm	
G 481	12X, 0.3N, 6.7E	L. J. Fox	200	Drl	242	6	20	do.	10	Force	3	Farm	Supplies 30 people.
G 482	12X, 0.7N, 6.5E	William Abjohnson	140	Drl	175	6	175	Pleistocene gravel	+14	Suction	..	Dom	Water rose 14 feet above land surface when well was drilled.
G 488	12X, 3.1N, 5.3E	P. J. Cleary	600	Drl	160	6	12	Mount Marion formation	37	None	7	None	Some water reported at 30 feet.
G 489	12X, 3.2N, 5.3E	M. F. McGovern	620	Drl	212	6	14	do.	50	do.	3	None	Some water reported at 8 feet.
G 491	12X, 3.4N, 5.0E	J. McGuire	670	Drl	125	6	5	do.	12	..	3	Dom	Yield 1 gpm at 75 feet.
G 494	12X, 2.6N, 9.3E	Albright Bros.	160	Drl	65	6	24	Deepkill shale	24	None	30	Farm	Drawdown less than 65 feet when pumped for 10 hours at rate of 30 gpm. Water rises to surface but well does not flow. [b]
G 495	12X, 2.0N, 9.3E	M. C. Albright	140	Drl	264	6	32	Normanskill shale	32	..	22	Farm	Yield 5 gpm at 60 feet, 13 gpm at 220 feet. [a]
G 498	12X, 2.5N, 10.3E	H. Mateer	100	Drl	180	6	12	do.	12	Force	4	Dom	Water reported to contain hydrogen sulfide.
G 502	12X, 2.2N, 5.7E	J. A. Deer	260	Drl	39	6	17	Onondaga limestone	17	do.	1	Dom	
G 503	12X, 0.6S, 7.0E	J. Takach	120	Drl	113	6	42	Normanskill shale	44	do.	½	Farm	
G 504	12X, 0.2S, 7.7E	Thomas Mokrzycki	180	Drl	100	6	7	do.	10	do.	2	Dom	
G 506	12X, 7.3S, 4.2E	Alpha Port. Cement Co.	100	Drl	150	6	..	Deepkill shale	..	Turbine	..	Dom	Pumped 24 hours a day. [a]
G 507	12X, 6.5S, 4.3E	Lehigh Cement Co.	110	Drl	190	6	4	do.	20	Force	3½	Dom	Main water bed reported at 150 feet. [a]
G 510	12X, 5.9S, 5.4E	North American Cement Corp.	90	Drl	67	6	41	do.	5	..	15	Dom	Temperature 53°F., September, 1945. [a]
G 511	12X, 5.9S, 4.6E	North American Cement Corp.	80	Drl	74	6	20	do.	8	Jet	6	Dom	Temperature 54°F., September, 1945. [a]
G 512	12X, 5.6S, 4.2E	North American Cement Corp.	120	Drl	104	6	40	Helderberg group	36	do.	10	Dom	Temperature 50°F., September, 1945. [a]
G 519	12X, 7.2S, 2.8E	Louis Bishop	160	Drl	30	6	5	do.	5	..	30	Farm	Flows seasonally. Main water bed reported at 10 to 20 feet.
G 520	12X, 6.6S, 2.7E	Mathias Wager	200	Drl	199	6	2	Onondaga limestone and Esopus siltstone	50	Force	1	Farm	
G 522	12X, 3.2S, 4.1E	Fred Smith	100	Dug	20	36	..	Pleistocene deposits	9	Pitcher	..	Dom	
G 524	12X, 4.1S, 0.8E	Mathew Story Estate	355	Drl	187	6	65	Catskill formation	15	..	40	Dom	Main water bed at 180 to 187 feet. [a]
G 527	12X, 2.0S, 1.5E	H. B. Overbaugh	360	Drl	128	6	20	do.	..	Pitcher	..	Farm	Well flows.
G 530	12X, 2.5S, 3.7E	Andrew Rhein	240	Drl	120	6	3	Mount Marion formation	17	..	4½	Com	Yield 2 gpm at 50 feet. [a]
G 532	12X, 1.5S, 5.3E	A. Bloznelis	40	Drl	210	6	100	Deepkill shale	40	Force	16	Dom	

See footnotes at end of table.

Table 6.—records of selected wells in Greene County, New York (Continued)

Well number	Location	Owner	Altitude above sea level (feet)	Type of well	Depth (feet)	Diameter (inches)	Depth to bedrock (feet)	Geologic subdivision	Water level below land surface (feet)	Method of lift	Yield (gallons per minute)	Use	Remarks
G 535	12X, 3.3S, 1.3E	School District 7	345	Drl	..	6	..	Catskill formation	..	Force	..	Dom	
G 539	12X, 4.9S, 12.5E	Frederick Edwards	480	Drl	77	6	42	do.	17	..	45	Dom	Main water bed at 70 to 77 feet. [b]
G 541	12W, 4.6S, 11.5E	M. A. Poulos	900	Drl	501	6	..	do.	250	None	5½	Dom	Yield 1 gpm at 250 feet.
G 545	12X, 2.0S, 2.5E	A. Wolff	480	Drl	130	6	10	do.	10	..	20	Com	Some water reported at 50 feet. Supplies swimming pool.
G 547	12X, 1.4S, 6.7E	R. W. Kerr	160	Drl	132	6	5	Normanskill shale	10	..	28	Com	Temperature 50°F., September, 1945. [b]
G 548	12W, 4.1S, 11.9E	W. Wache	600	Drl	90	6	10	Catskill formation	30	Force	5	Dom	Main water bed at 80 to 90 feet.
G 550	12X, 7.8S, 4.0E	H. W. Johnson	120	Drl	101	6	55	Normanskill shale	18	Suction	4	Dom	Main water bed at 85 to 100 feet.
G 552	12X, 0.4S, 4.7E	Michael Maxwell	160	Drl	175	6	144	Onondaga limestone	55	Jet	15	Com	Main water bed at 170 to 175 feet. [b]
G 554	12X, 1.2S, 4.7E	Aarno Sehm	200	Drl	185	6	85	Esopus siltstone	110	Force	5	Com	Yield 2 gpm at 100 feet.
G 557	12X, 3.9S, 1.2E	Kiskatom Dairies	320	Drl	100	6	8	Catskill formation	16	..	7	Farm	
G 558	12X, 4.6S, 1.1E	H. E. Jones	340	Drl	110	6	20	Ashokan formation	12	..	9	Dom	
G 560	12X, 3.3S, 1.4E	W. K. Van Hoesen	340	Drl	136	6	16	Catskill formation	18	..	5	Dom	
G 561	12X, 0.6N, 3.2E	Philip Krug	300	Drl	91	6	8	do.	..	..	30	Dom	Main water bed at 88 to 91 feet.
G 563	12X, 0.3N, 9.3E	F. E. Steedman	100	Drl	150	6	12	Normanskill shale	..	Jet	6	Com	Yield 1 gpm at 90 feet.
G 566	12X, 4.5S, 6.5E	J. Somers	60	Drl	190	6	100	do.	30	Force	8	Farm	
G 569	12X, 4.7S, 0.2E	O. Procida	320	Drl	140	6	10	Catskill formation	22	None	8	None	Main water bed at 110 to 140 feet.
G 570	12X, 2.6S, 0.7E	H. Katt	360	Drl	125	5	43	do.	41	Force	20	Farm	No drawdown reported after pumping at 20 gpm.
G 571	12X, 2.7S, 0.7E	J. Katt	360	Drl	70	6	8	do.	12	Suction	18	Dom	
G 574	12W, 5.3S, 12.0E	J. C. Trosino	540	Drl	84	6	..	Pleistocene gravel	30	Force	16	Dom	
G 575	12W, 5.2S, 11.5E	E. Griffin	600	Drl	150	6	27	Catskill formation	30	do.	8	Dom	
G 580	12X, 3.8S, 1.3E	Charles Margiotta	340	Drl	88	6	20	do.	4	..	3	Dom	
G 582	12W, 5.2S, 11.7E	C. L. Du Bois	560	Drl	85	6	42	do.	35	Force	15	Dom	Drawdown reported to be less than 50 feet after pumping at 15 gpm.
G 585	12W, 5.3S, 11.8E	John Glueck	540	Drl	49	6	43	do.	16	do.	5	Dom	
G 587	12W, 5.2S, 11.6E	N. Y. Telephone Co.	560	Drl	131	6	27	do.	27	do.	5	Dom	
G 595	12W, 5.3S, 11.9E	E. Hobart	200	Drl	28	6	6	Mount Marion formation	28	do.	3	Com	Supplies 30 people.
G 597	12X, 1.4S, 6.7E	Porto & Rich	170	Drl	152	6	21	Normanskill shale	22	None	½	None	
G 599	12X, 1.0S, 7.2E	Harold Finch	160	Drl	80	6	21	do.	15	..	2	Dom	
G 603	12X, 1.5S, 7.0E	J. E. Bronk	180	Drl	145	6	10	Deepkill shale	12	..	1½	Dom	
G 604	12X, 0.6S, 7.0E	J. Lasher	180	Drl	80	6	27	Normanskill shale	5	..	4	Com	
G 605	12X, 3.5S, 3.9E	Harold Holdridge	280	Drl	77	6	5	Esopus siltstone	12	Suction	..	Farm	(b).

See footnotes at end of table.

Table 6.—records of selected wells in Greene County, New York (Continued)

Well number	Location	Owner	Altitude above sea level (feet)	Type of well	Depth (feet)	Diameter (inches)	Depth to bedrock (feet)	Geologic subdivision	Water level below land surface (feet)	Method of lift	Yield (gallons per minute)	Use	Remarks
G 606	12X, 3.9S, 3.8E	C. Bloom	260	Drl	100	6	8	Esopus siltstone	8	Suction	..	Farm	Drawdown reported to be less than 90 feet when bailed at approximately 15 gpm.
G 608	12X, 6.0S, 2.9E	M. Relyea	180	Dug	28	48	21	Pleistocene till	8	..	..	Dom	
G 609	12X, 6.1S, 3.0E	M. Relyea	180	Drl	128	6	5	Onondaga limestone and Schoharie grit	28	Force	40	Farm	Some water reported at 28 feet.
G 611	12X, 3.3S, 6.5E	H. Everett	110	Drl	120	6	12	Normanskill shale	25	do.	4	Farm	

[a] For chemical analysis see table 4.
[b] For well log see table 5.

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